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SAFETY EVALUATION OF PHASE1 RETRIEVAL OF 241-C-106 FOR CLOSURE

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Abstract: This report documents a Hazard and Operability Analysis (HAZOP) for using project W-320 sluicing equipment to dissolve the soluble material in the sludge followed by transfer of the liquid waste in single-shell tank 241-C-106. Provides an analysis of the retrieval activiteis, hazardous conditions, and allocated controls as they related to the safety basis.

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Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

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Hanford Group, Inc.

Richland, Washington

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

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Date Published
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EXECUTIVE SUMMARY

This document provides a safety evaluation of the Phase 1 retrieval of liquid waste from single-shell tank 241-C-106 for closure using existing sluicing equipment to wash soluble material from the remaining sludge. Specifically, this safety evaluation encompasses the mobilization of soluble material from the sludge by sluicing with raw water and transferring the liquid waste in single-shell tank 241-C-106 to double-shell tank 241-AY-102. The hazardous conditions associated with this activity were identified during a Hazards and Operability Study. These hazardous conditions were used as the starting point in evaluating how this retrieval activity relates to the safety basis, specifically the analyzed accidents and their associated technical safety requirement controls. This document also describes the process and results of the control decision and the allocation process where controls necessary for prevention or mitigation of the consequences of the hazardous conditions were assigned or allocated.

The Hazards and Operability Study identified 102 hazardous conditions specific to the activity. Many of these hazardous conditions were derived from the hazard analysis prepared for the past-practice sluicing operation associated with Project W-320. The cross reference between the past-practice sluicing-related hazardous conditions and those for enhanced sluicing are found in the remarks section of the control decision record (Appendix D). All information in the control decision record is captured in HNF-SD-WM-TI-764, *Hazard Analysis Database Report*, which is part of the safety basis. In all cases, the hazardous conditions were directly related (mapped) to the representative accident and its associated accident analysis in HNF-SD-WM-SAR-067, *Tank Farms Final Safety Analysis Report*. No accidents of a different type were identified.

Of all the analyzed accidents applicable to the retrieval of liquid waste in single-shell tank 241-C-106, the consequence of two accidents was potentially increased. The first analyzed accident, tank failure due to excessive loads, is a load drop when removing the heel jet pump, which could rupture the tank dome and release more waste than was analyzed. This concern relates to the high lift height (over 100 feet) required to clear the disposal container and the potential holdup of 40 gallons of tank waste in the pump. The second concerned the analyzed accident, Natural Phenomenon – High Wind, related to wind damage to the flexible receiver. The relatively large holdup of waste in the pump was greater than that analyzed, thus, the potential increase in the consequence. The U.S. Department of Energy, Office of River Protection acknowledged these conditions and provided specific approval for removal of the long-length equipment from single-shell tank 241-C-106 by requiring additional controls as provided in Schepens (2002), "Approval of Long-Length Equipment Removal Activities for Single-Shell Tank (SST) 241-C-106."

Controls were allocated to the 102 hazardous conditions in accordance with the steps outlined in HNF-SD-WM-SAR-067, Section 3.3.1.5, "Control Identification." Table 5-1 of this report lists the hazardous conditions and the allocated controls. Controls are allocated as required by the final safety analysis risk matrix, Table 3.3.1.5-2. This matrix shows that low risk hazardous conditions (low frequency and/or low consequence) do not require technical safety requirement-level controls. Moderate risk hazardous conditions must have consideration of technical safety requirement-level controls and the high risk hazardous conditions must have technical safety requirement-level controls allocated. Except for the controls associated with

lifting the heel jet pump, all controls were found to be unaffected, requiring no changes or exemptions.

Finally, the effect of this retrieval activity on equipment important to safety was evaluated. There were no concerns identified where the frequency of occurrence or consequence could be increased. Operation of the sluicing system to wash the sludge will rely upon an active ventilation system to provide better visibility using the remote video cameras. A variable damper system is installed to adjust inlet flow to ensure a minimum negative pressure gradient in the tank vapor space. An evaluation of flammable gas generation (RPP-13547, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere*) concludes that with passive ventilation there is insufficient waste in the tank to achieve 25% of the lower flammability limit. Thus, only the passive ventilation system is required and is a safety class system. The active ventilation system being used will enhance operability of the system by reducing fog to increase visibility, but is not safety class or safety significant.

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LIST OF TERMS

AC	administrative control
AIChE	American Institute of Chemical Engineers
AWF	aging waste facility
BBI	best-basis inventory
CAM	continuous air monitor
CSER	criticality safety evaluation report
DID	defense-in-depth
DST	double-shell tank
FSAR	*Tank Farms Final Safety Analysis Report*
HAZOP	Hazards and Operability Study
HEPA	high-efficiency particulate air (filter)
HIHTL	hose-in-hose transfer line
LFL	lower flammability limit
LCO	limiting condition for operation
MAR	material at risk
OGT	over-ground transfer
Rep Acc	representative accident
SC	safety-class
SER	safety evaluation report
SS	safety-significant
SSC	structures, systems, and components
SST	single-shell tank
TOC	total organic carbon
TSR	*Tank Farms Technical Safety Requirements*
ULD	unit-liter dose
USQ	unreviewed safety question
WAC	*Washington Administrative Code*

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1.0 INTRODUCTION

1.1 PURPOSE

This safety evaluation for using existing sluicing equipment to dissolve the soluble material in the sludge and transfer the liquid waste in single-shell tank (SST) 241-C-106 to double-shell tank (DST) 241-AY-102 documents the results of the Hazard and Operability Study (HAZOP). This documentation provides a listing of the hazardous conditions identified during the HAZOP, including a discussion of how these conditions relate to the safety basis. This document also describes the process and results of the control decision, and the allocation process whereby the controls necessary for prevention or mitigation of the consequences of the hazardous conditions were assigned or allocated. Finally, this document provides an analysis of the retrieval activities, hazardous conditions, and allocated controls as they relate to the safety basis to previously identified hazardous conditions listed in HNF-SD-WM-TI-764, *Hazard Analysis Database Report*, the analyzed accidents described in HNF-SD-WM-SAR-067, *Tank Farms Final Safety Analysis Report* (FSAR), and controls prescribed in HNF-SD-WM-TSR-006, *Tank Farms Technical Safety Requirements* (TSR).

Specifically, this safety evaluation describes the use of existing sluicing equipment to mobilize the sludge in SST 241-C-106 with raw water, and thus dissolve soluble materials and transfer the liquid waste to DST 241-AY-102 via a combination of compliant underground transfer lines and a hose-in-hose transfer line (HIHTL).

This document is not intended to authorize the activity. Previously identified hazardous conditions common to the tank farms, and not specifically related to this retrieval activity, are not captured. Authorization issues are addressed by the unreviewed safety question (USQ) evaluation process. Furthermore, this safety evaluation provides a comparison to existing accident analysis, but does not include revisions to those analyses. Likewise, this safety evaluation does not include new accident analyses.

1.2 BACKGROUND

Retrieval of residual waste in SST 241-C-106 is required to demonstrate interim closure as required by the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) milestones M-45, M-45-06A, M-45-05N-T01, M-45-05H, and the waste management requirements of *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations." Milestone M-45 requires the closure of SST farms and states that closure will follow retrieval of as much tank waste as technically possible with tank waste residues not to exceed 360 ft^3 in each of the 100-series tanks, or the limit of waste retrieval technology capability, whichever is less.

In the late 1990s, a waste retrieval effort was initiated in SST 241-C-106 as a Project W-320 activity in November 1998 and completed in October 1999 (RPP-6696, *Data to Support Tank C-106 Waste Retrieval Determination*). The retrieval effort was completed in accordance with the requirements of Milestone M-45-03B. Retrieval was performed using the Project W-320 sluicing system. Approximately 187 kgal of the estimated 192 kgal (i.e., 97%) of sludge in SST 241-C-106 were sluiced to DST 241-AY-102. Sluicing operations were conducted using DST 241-AY-102 supernatant as a sluicing medium. The purpose of the waste retrieval effort was to resolve the SST 241-C-106 high-heat safety issue and demonstrate a sluicing retrieval technology. Before a tank farm can be closed, Milestone M-45 requires retrieval of as much waste as technically possible and not to leave more than a residual volume of 360 ft^3, whichever is less. Post-sluicing estimates indicate approximately 18,000 gal of liquid and 1,200 ft^3 of residual sludge currently remain in SST 241-C-106 (RPP-12547, *Tank 241-C-106 Residual Liquids and Solids Volume Calculation*). The first phase of the retrieval activity evaluates the use of fresh water sluicing to dissolve soluble material from the sludge remaining from past sluicing activities and the subsequent transfer of liquid waste to DST 241-AY-102.

2.0 DESCRIPTION OF PHASE 1 RETRIEVAL OF SINGLE-SHELL TANK 241-C-106

2.1 DESCRIPTION OF THE RETRIEVAL SYSTEM

The waste retrieval system is designed to retrieve radioactive liquid from SST 241-C-106, leaving a residual of no more than 360 ft^3 (2,700 gal) in the tank. The retrieval activity will use the existing sluicing nozzles installed in Riser 3 to mobilize the remaining sludge and solids with raw water, thereby releasing captive liquid and dissolving any remaining salt. Figure 2-1 is a general sketch of the retrieval system and the transfer route to the receiver tank, DST 241-AY-102. The piping and instrumentation diagram for the retrieval system is documented in H-14-105666, *Instrumentation 241-C-106 Waste Retrieval P&ID.*

2.1.1 Sluicing System

Sluice Nozzle Assembly: The existing sluicer in Riser 3, located in the C-06C pit, will be used. The sluicer is constructed of 304L stainless steel and has a 1-in. diameter nozzle with two degrees of motion control (rotation 194° and nozzle elevation 130°). The nozzle pivots/rotates at a fixed elevation in the tank and can be aimed with a dedicated hydraulic system. The sluicer is vertically articulated with its articulation point located at a fixed elevation (15.5 ft above the bottom center of the tank) as high in the tank as is practical. The sluicer base plate also has a high capacity drain. The sluicer controls, located in the MO-211 control room, have two modes: manual and semi-automatic.

Sluice Water Supply System and Transfer Route: Figure 2-1 also shows how fresh water is supplied to the sluicing system. A diesel powered booster pump will pump raw water from the 241-AY Tank Farm, through nozzle U-2 in the AY-02E pit, to supply the sluicer via transfer line SN-200. The raw water is supplied from hydrant R-16-A (also known as R-16-AZ) or alternately may be supplied by a water supply truck. The pump is designed to provide a flow of 350 gal/min at a pressure of 200 lb/in^2 gauge at the sluice nozzle in SST 241-C-106. The maximum deadhead pressure is 205 lb/in^2 gauge. The raw water transfer line is the same waste transfer line used previously to transfer supernatant as a sluicing liquid from DST 241-AY-102 back to SST 241-C-106 (transfer line SN-200).

2.1.2 Supernatant Transfer Pump

Figure 2-2 is a sketch of the supernatant transfer pump (H-14-104773-1, *C-106 Retrieval Supernate Removal Pump Assy and Details*). This pump was fabricated from two model BS-2060 Flygt[1] pumps connected in series. Two pumps were required to achieve the pressure head needed to pump the supernatant upgrade to the receiver tank. The hydraulic properties of

[1] Flygt is a trademark of ITT Flygt Corporation, Trumbull, Connecticut.

this pump assembly (flow and head) are shown in Figures 2-3 and 2-4 (RPP-6638, *DST Annulus Pumping Acceptance Test Report*).

Figure 2-1. General Arrangement of the SST 241-C-106 Phase 1 Retrieval System.

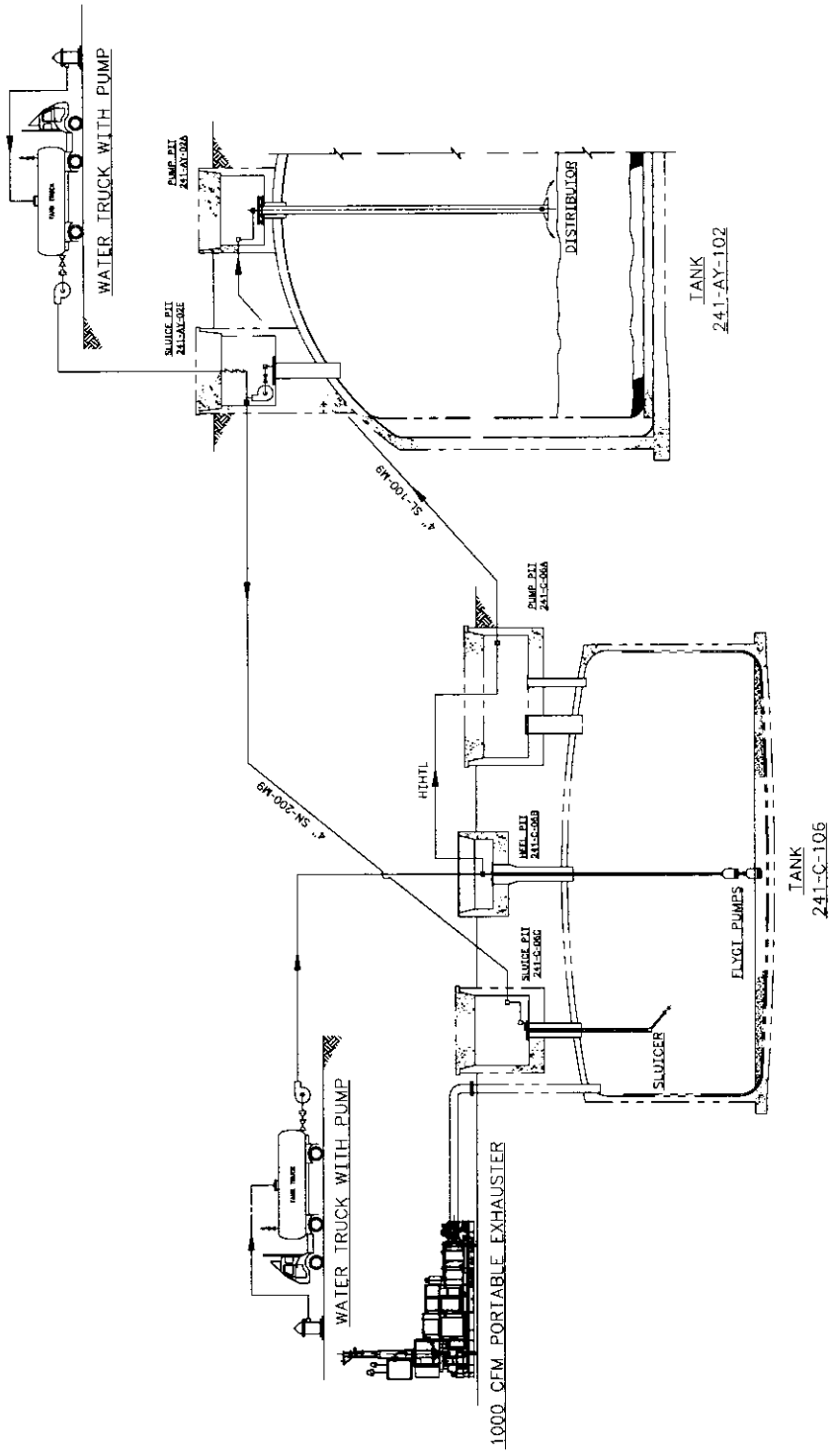
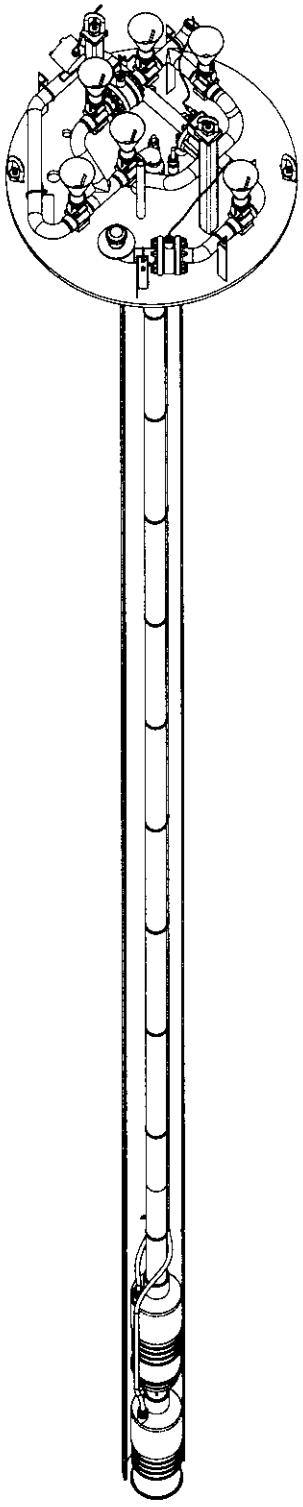


Figure 2-2. Dual Flygt Model BS-2060 Supernatant Pump Assembly.



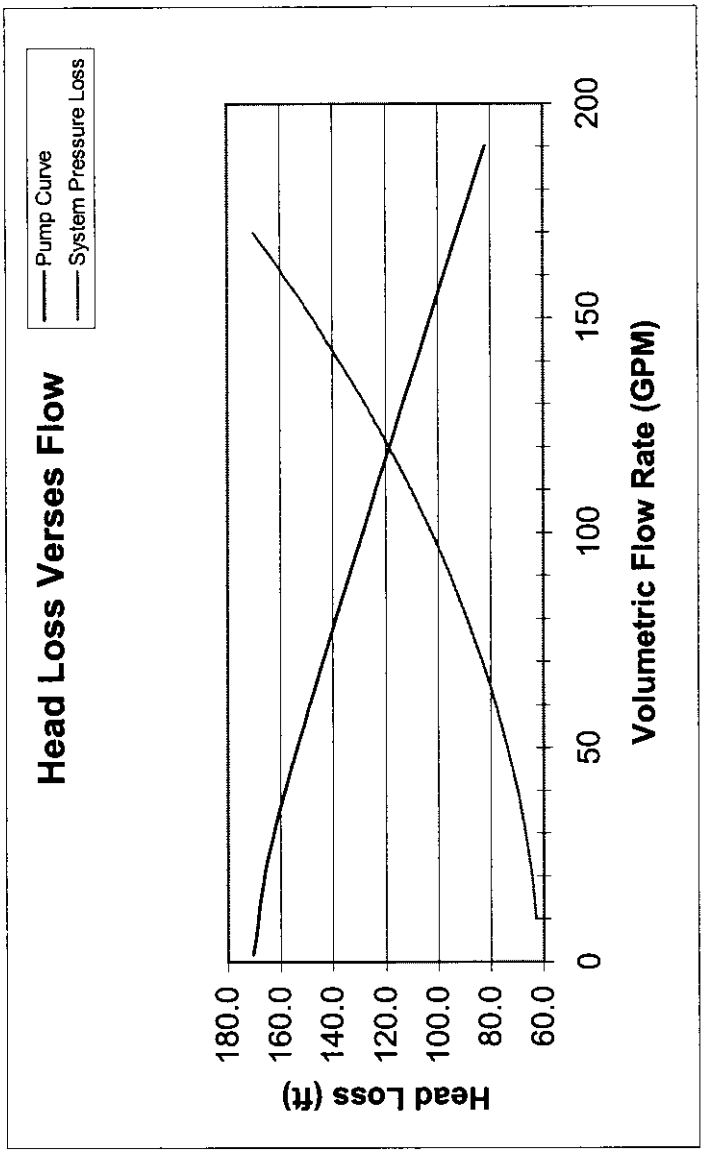
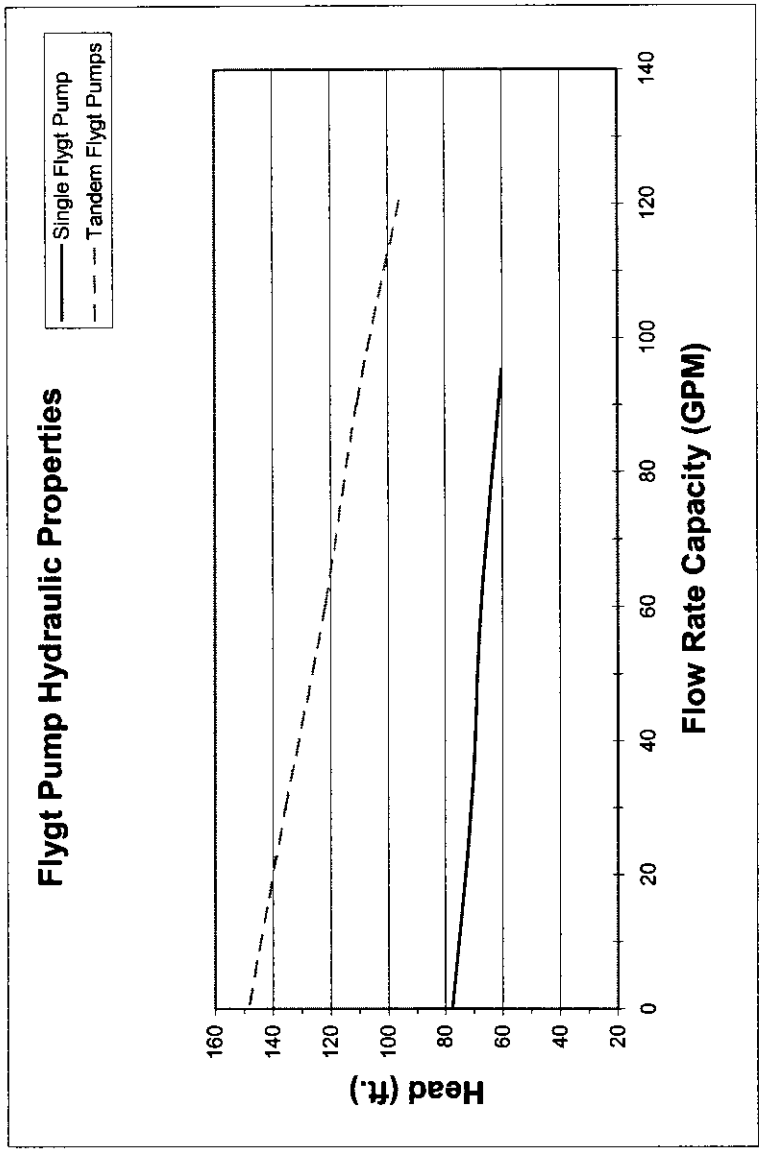


Figure 2-3. Head Loss vs. Volumetric Flow Rate for Two Model BS-2060 Flygt Pumps In Series.

Figure 2-4. Pressure Vs Flow Rate For Model BS-2060 Flygt Pumps for Either a Single Pump or Two Pumps In Tandem.



2.1.3 Supernatant Transfer Route

The transfer route to be used transports waste from SST 241-C-106 to DST 241-AY-102. The transfer line is a combination of aboveground HIHTL and underground encased steel pipe. The transferred supernatant is discharged through a slurry distributor. Major components of the transfer route are described in the following paragraphs.

Hose-In-Hose: Radioactive liquid waste is transferred from the C-06B heel pit via an aboveground HIHTL to the C-06A pump pit. A jumper is installed, connecting the aboveground HIHTL entering the C-06A pit to the 4-in. SL-100 underground pipeline at nozzle number 9. The cover blocks for both the C-06A and C-06B pits are designed to provide both shielding and mechanical protection to the HIHTL as it transitions into the pits. The lines are laid in a shallow depression in the soil and covered with 2-in. thick steel plates for both radiation shielding and mechanical protection. The primary transfer hose has a working pressure of 425 lb/in^2, well within the 64.2 lb/in^2 maximum (deadheaded pressure) of the supernatant transfer pump (RPP-6638). The outer hose is designed to contain any leakage of the primary hose and to direct it to either to the C-06A and C-06B pits for detection by the transfer leak detectors.

Encased Buried Transfer Line: The transfer line from SST 241-C-106 C-06A pump pit to DST 241-AY-102 is the SL-100 4-in. encased pipeline, approximately 0.3 mi long. The primary line (inner pipe) is designed for a maximum pressure of 320 lb/in^2, well above the 64.2 lb/in^2 deadheaded pressure from the supernatant transfer pump (RPP-6638). The encasements are designed to direct the flow of leaked waste from the primary line to transfer related structures for detection.

DST 241-AY-102 Down Leg/Slurry Distributor: The supernatant transferred from SST 241-C-106 is discharged into DST 241-AY-102 through a slurry distributor. It is installed in 241-AY-02A pit in Riser 6. The slurry distributor is a straight 4-in. nominal pipe with four 2-in. diameter horizontal nozzles spaced at 90° intervals at a fixed 12.5 ft elevation in the tank. A high capacity drain is incorporated into the slurry distributor head, sized to drain all liquid from within the pit in the event of a transfer line break during a transfer. A drain plug is available to seal the high capacity drain when pit covers are removed.

Sump Pumps: Existing sump pumps will be used in the C-06A pump pit, and the C-06C sluice pit, and a new sump pump will be installed in the C-06B heel pit. The sump pumps will be one-third horsepower pumps with a flow of 10 gal/min, and will discharge into risers 9, 3, and 13.

2.1.4 Ventilation System

SST 241-C-106 ventilation is accomplished by two independent systems. The first is a passive ventilation system (breather filter assembly) relied upon to provide assurance that flammable gas levels do not exceed 25% of the lower flammability limit (LFL). The breather filter assembly is a standard design used throughout tank farms consisting of a standard high-efficiency particulate air (HEPA) filter/housing, isolation valve, and seal loop. The assembly is designed to be mounted vertically on a tank riser, and is mounted on Riser 19. The passive ventilation system is the permanent ventilation system for this tank.

The second system is a temporary, active ventilation system used during sluicing activities. The active ventilation system consists of an air inlet/vacuum control assembly and a portable 1,000 ft^3/min exhauster. An air inlet/vacuum control assembly is installed on SST 241-C-106 to allow control of tank vacuum levels to prevent uplift of the tank bottom. This assembly consists of three basic elements: (1) a 12-in. diameter isolation butterfly valve, (2) a standard 1,000 ft^3/min HEPA filter/housing, and (3) a vacuum controller connected to the inlet of the HEPA housing. The valve, filter housing, and vacuum controller are assembled in a vertical arrangement designed for mounting directly on a tank riser. The air inlet/vacuum control assembly is located at a 12-in. riser on the SST 241-C-106 ventilation hatchway, Riser 15 (the ventilation hatchway allows multiple connections to the tank).

The 1,000 ft^3/min skid-mounted portable exhauster consists of an inlet isolation valve, de-entrainer/heater section, pre-filter, two HEPA filters, two HEPA test sections, fan, stack, a stack monitoring system, and instrument enclosures. The de-entrainer removes aerosols that may be produced from operations in the tank and thereby protects the filters from moisture loading. The heater lowers the relative humidity of the air stream and also serves to reduce moisture loading of the filters. The exhauster is capable of 1,000 ft^3/min at 12.7 in. water gauge. It has a variable speed drive and can be adjusted from 440 ft^3/min to 1,000 ft^3/min. Instrumentation and a programmable logic controller allow for alarms and interlocks to monitor and control system operating parameters. Details of the portable exhauster are found in RPP-13222, *Evaluation of Temporary Ventilation System to Support Tank 241-C-106 Waste Retrieval System*. The portable exhauster is installed in an area roughly between SSTs 241-C-103, 241-C-105, and 241-C-106. It is connected to tank riser, Riser 2, in SST 241-C-106 via an 8-in. diameter ductwork assembly. Portions of these pipe/duct systems will be removed/isolated from Riser 2 as necessary to allow connection of the 1,000 ft^3/min portable exhauster.

2.1.5 System Instrumentation and Controls

H-14-105666 shows the instrumentation used to control this retrieval operation. All controls are mounted locally on an electrical rack inside a National Electrical Manufacturers' Association 3R, 4 or 4X enclosure. This includes the two motor starters: instrumentation and power. Each supernatant transfer pump is started separately with the lower pump started first. When pressure is detected on the transfer line, the second motor is started. The Flygt pumps are interlocked to shut down on leak detection or leak detection failure. Sump pumps located in the pits are operated manually, as required, following leak detection indication. Ammeters are installed locally to monitor the pumps.

Raw water is used to flush the transfer line, the pumps, and to dilute the existing liquid in the tank. Local pressure gauges are used on the upstream and downstream side of a ball valve at the raw water connection to ensure that the pressure is zero before the raw water is connected. Pressure on the downstream side will be less than the upstream side to ensure that no waste can migrate to the raw water system. Raw water for flushing will be provided by tank truck or via a hose that attaches to the raw water supply hydrant.

2.2 SITE PREPARATION AND EQUIPMENT INSTALLATION

The following describes the removal and installation of equipment to be done or previously completed in the riser and pits in SST 241-C-106:

Riser 3 (12 in. diameter in the C-06C sluice pit):

Evaluate the condition and refurbish if necessary the past-practice sluicer assembly previously installed.

Riser 7 (12 in. diameter in the C-06A pump pit):

Install a camera.

Riser 13 (12 in. diameter in the C-06B heel pit):

Remove existing heel jet pump. Install the supernatant transfer pump.

Riser 14 (4-in. diameter riser):

Remove the existing thermocouple tree and replace it with a remote video camera installed for visual inspections and sluicer operations.

Pit C-06A (Pump Pit):

A new flexible jumper will be installed at the HIHTL from the C-06B pit to the 4-in. SL-100 transfer line. A new leak detector is installed and used in conjunction with the sump pump as a safety system designed to return any waste that is leaked into the pump pit back to the tank.

Concrete cover blocks will be replaced with steel cover plates. The new pit plate is designed and installed to accommodate the insertion and operation of a camera in Riser 7 and the HIHTL from C-06B.

Pit C-06B (Heel Pit):

A new pit cover plate is designed and installed to accommodate the insertion and operation of the new transfer pump, waste removal lines, and associated plumbing controls and equipment.

The existing heel jet pump is removed.

A new leak detector is installed in this pit to shutdown the transfer pump if leakage should occur.

Pit C-06C (Sluice Pit):

The existing sluicer may be used to add raw water and/or acid to the tank if necessary.

2.3 SLUICING OPERATIONS

Prior to liquid waste removal, the sluicer located in C-06C sluice pit is operated to knock down and spread out the piles of sludge left over from previous operations, and wash out the fines from the sludge to the maximum extent possible. The desired state is to have all the solids relocated below the knuckle of the tank. Raw water will continue to be added to the tank, raising the liquid level to submerse the supernatant transfer pump intake. Once the lower of the dual transfer pumps is completely submersed, the pumps will be started and waste transfer will proceed. This process will be performed on localized areas and repeated to pick up soluble materials and remove them from the tank.

2.4 SUPERNATANT TRANSFER OPERATIONS

Supernatant transfer operations will be started as soon after stopping the water addition/washing as is practical. A short amount of time between sluicing and the transfer is planned to allow solids to settle out, thus minimizing the amount of solids in the transfer. The sluicing/transfer operation may cover several of these cycles.

Fluid pressure, waste flow rate, and pump motor current are monitored during the waste transfer. A camera may also be installed in Riser 7 or Riser 14 to allow visual observation/monitoring of the pumping operation. Following pump shutdown, the operator may allow fluid (line holdup) to drain back into SST 241-C-106, or may shut the transfer line discharge valve to prevent fluid drain back if it is undesirable.

Upon completion of the liquid waste retrieval or pump failure, the preliminary pump assembly may be removed from Riser 13. Riser 13 would then be available for installation of a backup slurry transfer pump for SST 241-C-106 waste retrieval.

2.5 SUPERNATANT TRANSFER LINE FLUSHING

The transfer line will be cleared by flushing the line with raw water and allowing drainback to 241-C-106. Water will be supplied from the 241-A Tank Farm hydrant or from a water tank truck.

3.0 HAZARD IDENTIFICATION

3.1 METHODOLOGY

The hazards identification and evaluation for Phase 1 retrieval of liquid waste in SST 241-C-106 for closure used the HAZOP method. In a HAZOP, a team leader systematically guides the HAZOP team through the system/process being evaluated using a fixed set of process parameters (e.g., flow, pressure, temperature) and guide words (e.g., high, low, more, less). The combinations of the process parameters and guide words are applied at specific points or "nodes" in the system design to identify potential hazardous conditions associated with the operation of the system.

The HAZOP was performed by an interdisciplinary team to identify potential hazardous conditions within an agreed upon scope. Because the HAZOP process tends to be qualitative in nature, the expertise and experience of the team is of primary importance in establishing the credibility of the analysis. A short resume of each team member is included in Appendix B to document the expertise and experience level of each team member.

A HAZOP is a systematic process that investigates upset conditions or variations of combinations of process parameters and guide words (the combinations are generally referred to as "deviations") that could potentially result in undesirable consequences. Process variables are the characteristics of a process (e.g., flow, pressure, or temperature) used to define proper operation. The guide words describe the variance in the process variable of concern (e.g., high, low, more, or less). The deviation guide for process variables is provided in Table 3-1. During the HAZOP process, potential consequences of the deviations were estimated, hazardous conditions formulated, and possible corrective and/or preventive measures identified and discussed. This process is recognized by the American Institute of Chemical Engineers (AIChE) and is described in *Guidelines for Hazard Evaluation Procedures* (AIChE 1992). The HAZOP uses a tabular format to record the results of the systematic process. Definitions prepared during the HAZOP process are provided in Appendix C.

One of the features of a HAZOP is the division of a process or activity into discrete segments called nodes. Each node represents a specific part of the process or activity. Node selection is designed to facilitate the hazard identification process. The HAZOP was based on the following nodes to capture points in the process where deviations could result in significant consequences:

- **Node A:** Equipment Installation and Decommissioning
- **Node B:** Process Water Supply System, including Flush Systems for Transfer Lines
- **Node C:** Sluicing System
- **Node D:** Supernatant Transfer Pump
- **Node E:** Transfer Line, SST 241-C-106 to DST 241-AY-102
- **Node F:** 241-C-106 Ventilation System
- **Node G:** Receiver DST Ventilation System (241-AY-102)
- **Node H:** SST 241-C-106
- **Node I:** Receiver DST (241-AY-102)
- **Node J:** Instrumentation and Controls.

Table 3-1. Deviation Guide For Process Variables.

Process variables	Guide words						
	NO, NOT, NONE	LESS, LOW, SHORT	MORE, HIGH, LONG	PART OF	AS WELL AS, ALSO	OTHER THAN	REVERSE
DOSE	Not Planned Not Measured	Too Low	Too High	--	Miscalculated	Missing Source	
FLOW	No Flow	Low Rate, Low Total	High Rate, High Total	Missing Ingredient	Misdirection, Impurities	Wrong Material	Backflow
PRESSURE	Open to Atmosphere	Low Pressure	High Pressure	--	--	--	Vacuum
TEMPERATURE	Freezing	Low Temperature	High Temperature	--	--	--	Auto-refrigeration
LEVEL	Empty	Low Level	High Level	Low Interface	High Interface	--	
AGITATION	No Mixing	Poor Mixing	Excessive Mixing	Mixing Interruption	Foaming	--	Phase Separation
MATERIAL	Not Added	To Little	Too Much	Missing Ingredient	Impure	Wrong Ingredient	Removed
REACTION	No Reaction	Slow Reaction	Runaway Reaction	Partial Reaction	Side Reaction	Wrong Reaction	Decomposition
TIME PROCEDURE	Skipped or missing Step	Too Short, Too Little	Too Long, Too Much	Action(s) Skipped	Extra Action(s) (Shortcuts)	Wrong Action	Out of Order, Opposite
SPEED	Stopped	Too Slow	Too Fast	Out of Sync	--	Web or Belt Break	Backward
Ph	--	Low pH	High pH	--	Additional Acid, Additional Base	Wrong Acid, Wrong Base	--
CONCENTRATION	Not Measured	Low Concentration	High Concentration	Missing Ingredient	--	Additional Ingredient	Wrong Instrument
VISCOSITY	--	Low Viscosity	High Viscosity	--	--	--	--
VOLTAGE	No Voltage	Voltage Low	Voltage High	Wrong Waveform	Interference Voltage	Wrong Frequency, AC instead of DC DC instead of AC	Wrong Polarity
CURRENT	No Current	Current High	Current Low	--	--	Current Fluctuating	Wrong Polarity
STATIC	--	--	Static Charge	--	--	--	--
SPECIAL	Utility Failure	External Leak	External Rupture	Tube Leak	Tube Rupture	Startup, Shutdown, Maintenance	--
STRUCTURAL STRENGTH	Structural Failure	Less Strength	More Strength	--	--	--	--
SHIELDING	--	Less Shielding	More Shielding	--	--	--	--
POSITION	Not Aligned	Too Low	Too High	Miscounted	Misdirected	Wrong Direction Wrong Location	Backwards Upside down
HOISTING	Not Controlled	Too Light	Too Heavy	Not Free	Damaged Rigging	Wrong Rigging	Reverse Signals
LOAD	Not Controlled	Too Light	Too Heavy	Not accounted for	Mispositioned	--	--
TORQUE	Not torqued	Too Low	Too High	Not calculated	--	Wrong direction	Reverse Rotation

Notes:
AC = alternating current.
DC = direct current.

3.2 ASSUMPTIONS

The following assumptions were developed by the HAZOP team to facilitate the initial hazard identification sessions of the HAZOP.

- Where a leak is postulated with a pit overflow, the pit drain is assumed to be blocked.
- Where a leak is postulated into a waste tank from a pit, the pit drains are assumed to be open.
- Where a flammable gas hazard is postulated, an active ignition source is assumed.
- Where a leak or spray is postulated due to the transfer pump pressure, the transfer piping or connections are assumed to be weakened or degraded such that the relatively low pump pressures could result in a failure. Failure could be the result of flaws already present but not previously identified, e.g., corrosion, incorrect assembly, or material defects.

3.3 HAZARD AND OPERABILITY STUDY RESULTS

The HAZOP team identified 102 hazardous conditions associated with Phase 1 retrieval of liquid waste in SST 241-C-106 for closure. The detailed information developed during the hazard identification team meeting is presented in Appendix E. These specific hazardous conditions are similar to others and can be separated or grouped by a generalized hazardous condition (e.g., specific hazardous conditions related to spray leaks are grouped together under a generalized waste transfer leak hazardous condition). Table 3-2 lists 14 generalized hazardous conditions, and provides a node-by-node breakdown of how many of these types of conditions were identified for each node of the analysis. The table also lists the total number for each generalized hazardous condition, as well as the total number of all types of hazardous conditions identified for each node.

The 102 hazardous conditions identified by the HAZOP team provide the basis for the evaluation of Phase 1 retrieval of liquid waste in SST 241-C-106 for closure. The information in Appendix E is included as a historical record of the HAZOP hazard identification sessions and should be considered as raw data not having been subjected to formal analysis and review. The information in Chapters 4.0 and 5.0 presents the final statement of the hazardous conditions and provides an analysis of final retrieval of waste in SST 241-C-106 for closure.

Table 3-2. Generalized Hazardous Conditions.

General hazardous condition	Numbers of hazardous conditions for each node										
	A	B	C	D	E	F	G	H	I	J	Total
Miscellaneous low consequence hazardous conditions	-	-	6	2	4	1	-	-	-	-	13
Release of radioactive or hazardous material from a waste tank due to a nuclear criticality	-	-	2	1	-	-	-	1	-	-	4
Release of radioactive or hazardous materials from a waste tank due to mixing of incompatible material resulting in tank pressurization	-	-	-	-	-	-	-	-	1	-	1
Release of radioactive or hazardous material from a waste tank due to a flammable gas deflagration	2	2	4	1	2		-	3	2	2	18
Release of radioactive material from a failed HEPA filter due to exposure to high temperature or pressure	3	-	-	1	1	2	3	-	-	-	10
Release of radioactive or hazardous material due to a fire in a contaminated area	1	1	-	1	-	-	-	-	-	-	3
Release of radioactive or hazardous material from a DST due to an organic solvent fire	-	-	-	-	-	-	-	2	-	-	2
Release of radioactive or hazardous material from a damaged dome due to excessive loads	4	1	-	-	2	-	-	-	1	-	8
Release of radioactive or hazardous material from a damaged tank due to vacuum-induced damage to the tank or liner	-	-	2	-	-	3	-	-	-	-	5
Release of radioactive or hazardous material from damaged tanks, transfer lines, or structures due to seismic-induced damage	-	-	-	-	2	1	-	-	-	-	3
Release of radioactive or hazardous material from a damaged ventilation system due to a steam eruption	-	1	2	-	-	-	1	-	-	-	4
Release of radioactive or hazardous material due to an unfiltered release caused by damage to ventilation systems or other structures	1	-	1	-	-	3	-	1	-	-	6
Release of toxic fumes or vapors from a waste tank due to mixing of incompatible material	-	-	-	-	-	-	-	-	1	-	1
Release of radioactive or hazardous material from transfer lines or structures due to a waste transfer leak	1	4	3	5	7	-	1	1	2	-	24
Total	12	9	20	11	18	10	5	8	7	2	**102**

Notes:
DST = double-shell tank.
HEPA = high-efficiency particulate air.

4.0 SAFETY EVALUATION

This evaluation provides a comparison of the hazardous condition as they relate to the safety basis, specifically to the analyzed accidents in the FSAR and the TSR-level controls. The following three general areas of concern are addressed in the following sections.

- Does this activity constitute a new or unique accident?
- How does this activity affect the analyzed accidents?
- How does this activity affect equipment important to safety?

4.1 IDENTIFICATION OF A UNIQUE ACCIDENT

The following question is evaluated in this section: *Do any of the newly identified hazardous conditions represent or provide an indication of a new type of accident?*

A comparison was made of the existing hazardous conditions in the hazard analysis database to the hazardous conditions specific to Phase 1 retrieval of the liquid waste in SST 241-C-106 for closure. The methodology for hazard identification, as stated in Section 3.1, provides assurance that all major hazardous conditions and release mechanisms have been identified. Also, the review process associated with control allocation described in Section 5.1 provides additional assurance that the postulated cause, frequency of occurrence, and consequence of the hazardous condition is correct and accurate.

The hazardous conditions identified for this activity were compared to those currently included in the hazard analysis database. None were found to be unique, insofar as they are all analogous to existing hazardous conditions. The only major difference is these conditions are stated such that they relate or reference directly to this specific retrieval activity, namely retrieval of the waste in SST 241-C-106 for closure. Therefore, it is concluded that no hazard associated with this activity represents a new type of accident.

4.2 EFFECT ON ANALYZED ACCIDENTS

The following question is evaluated in this section: *Do any of the newly identified hazardous conditions adversely affect the analyzed accident such that there would be a significant increase in the frequency of occurrence, an increase in the consequence of an analyzed accident, or an adverse effect on a TSR or other safety basis control?*

The finalized hazardous conditions related to Phase 1 retrieval of the liquid waste in SST 241-C-106 for closure are associated with the following analyzed accidents from the FSAR:

- Nuclear Criticality (Representative Accident [Rep Acc] 01)
- Mixing of Incompatible Material—Tank Pressurization (Rep Acc 03)
- Flammable Gas Deflagrations—DST (Rep Acc 04)
- Flammable Gas Deflagrations—SST (Rep Acc 05)

- HEPA Filter Failure—Exposure to High Temperature or Pressure (Rep Acc 06)
- Fire in Contaminated Area (Rep Acc 07)
- Organic Solvent Fire (Rep Acc 09)
- Tank Failure due to Excessive Loads (Rep Acc 12b)
- Tank Failure due to Vacuum or Degradation (Rep Acc 13)
- Tank Bump (Rep Acc 18A)
- Unfiltered Release (Rep Acc 18B)
- Mixing of Incompatible Material—Toxic Vapor Generation (Rep Acc 23)
- Aboveground Structure Failure (Rep Acc 31)
- Waste Transfer Leak into Structure (Rep Acc 33A)
- Waste Transfer Leak into Soil Surface or into Atmosphere (Rep Acc 33C)
- Waste Transfer Leak Due to Misroute (Rep Acc 33D).

Nuclear Criticality (Rep Acc 01):

Frequency of Occurrence: The nuclear criticality accident analysis in the FSAR, Section 3.3.2.4.1, states that under current operating conditions, a nuclear criticality accident is incredible in any of the SSTs or DSTs at the Hanford Site. The plutonium concentration is too low for criticality, the neutron absorbers co-located with the plutonium are sufficient to preclude criticality, and no credible means exist for concentrating sufficient plutonium to go critical. The technical evaluation of criticality (RPP-7475, *Criticality Safety Evaluation of Hanford Tank Farms Facility*) concludes that there is no condition created by any supernatant transfer that would result in an unplanned criticality. Therefore, there will be no increase in the frequency of occurrence for this analyzed accident.

Consequence: The consequence of an unplanned nuclear criticality in a waste tank includes release of radioactive noble gases, iodine, aerosolized plutonium, and tank waste (FSAR, Section 3.3.2.4.1). The analyzed accident shows that this event affects only the onsite worker. The noble gases, iodine, and plutonium would be a result of the fission and thus are considered a constant regardless of where the event happened. Thus, the only concern is if the dose from the specific tank waste release is greater than that analyzed. The analyses shows that the criticality would release 6.00 E-05 L of DST waste. The onsite unit-liter dose (ULD) for the nominal DST waste is listed as 9.47 E05 Sv/L for DST solids and 6.1 E03 Sv/L for DST liquids (RPP-5924, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, Table 4-5). There will be no increase in the ULD of SST 241-C-106 and, as the liquid transfer progresses, the ULD will be decreased. Thus, there will be no increase in the consequence of an unplanned criticality in this tank.

A transfer of liquid waste from SST 241-C-106 to DST 241-AY-102 would result in a combined supernatant onsite ULD of 2.37 E01 Sv/L (Appendix A, Table A-10). The onsite ULD for the combined supernatant is much less than that analyzed for the nominal DST. The enhanced sluicing operation will transfer minimal amounts of solids and thus could change the ULD in the receiver tanks.

There remains the possibility of transfer of some of the sludge during the supernatant transfers. Conservatively, the combination of all the sludges from SST 241-C-106 and DST 241-AY-102 has an onsite ULD of 3.08 E04 Sv/L (Appendix A, Table A-11), again lower than the accident analysis.

In all cases, the ULD remains lower than that used in the FSAR accident analysis. It is therefore concluded that enhanced sluicing of SST 241-C-106 and subsequent slurry transfer to DST 241-AY-102 will not cause an increase in the consequence of the nuclear criticality analyzed accident.

Controls: The control associated with the criticality analyzed accident (Administrative Control [AC] 5.7, "Nuclear Criticality Safety") is preventive in nature. It requires that criticality limits and controls be documented in criticality safety evaluation reports (CSER) and requirements implemented in criticality prevention specifications and procedures. Sluicing the sludge in SST 241-C-106 using fresh water with subsequent transfers of the waste has been evaluated in a CSER (RPP-7475). The conclusion of the CSER shows that this activity will not, in and of itself, result in a criticality; therefore, there are no requirements for additional controls or changes to criticality prevention specifications specific to this activity.

Mixing of Incompatible Material—Tank Pressurization (Rep Acc 03):

Frequency of Occurrence: A review of the hazard analysis database found that the hazardous conditions identified for this retrieval activity and applicable (mapped) to this analyzed accident is similar in nature and thus an analysis of this analyzed accident is included. The frequency of occurrence without controls for the analyzed accident is listed as "anticipated" (F3) in FSAR, Table 3.3.2.4.12-1. The hazardous conditions related to this activity were determined to be "anticipated" (F3). However, analysis documented in Reynolds (2001), "Potential for Tank Farm Systems to Give Off Toxic Chemicals or Pressurize Due to Chemical Incompatibility," indicates that these proposed transfers would not react; therefore, it can be concluded that the activity would not create a situation where tank pressurization is a certainty. The TSR-level controls for this accident are established to decrease the probability of an occurrence and thus are considered preventive. In this case, the control relates only to chemical addition and is not applicable. Therefore, the preventive control is not affected and the mitigated frequency of occurrence is not changed. It is concluded that this activity would not increase the frequency of occurrence of this analyzed accident.

Consequence: The activity involves only transfer of tank waste from SST 241-C-106 to DST 241-AY-102. The analyzed accident in FSAR, Table 3.3.2.4.12-1, shows that radiological and toxicological consequences would exceed the onsite evaluation guidelines (S2) but would not exceed offsite evaluation guidelines. The analyzed accident scenario is based on an inadvertent low pH transfer in to a double-contained receiver tank as opposed to adding service water to an SST or SST waste to a DST. The accident analysis uses a source term of two-thirds DST liquid and one-third DST solids. A conservative ULD value for a one-third solid and two-thirds liquid slurry for SST 241-C-106 and receiver tank DST 241-AY-102, after receipt of the transferred waste, remain well below the source term in the analyzed accident as shown in Appendix A, Table A-13. Therefore, it is concluded that Phase 1 retrieval of the liquid waste from SST 241-C-106 with transfer to DST 241-AY-102 will not increase the consequence of this analyzed accident.

Controls: There are three TSR-level controls used as both preventive and mitigative measures. The first control (AC 5.12, "Transfer Controls") is credited to prevent transfer of high pH chemicals to waste tanks as a preventive measure. There are no chemical transfers associated with this retrieval activity, thus, there is no effect on this control. A second control

(AC 5.19, "Process Instrumentation and Measuring and Test Equipment") is also credited to ensure that equipment that measures process parameters is properly maintained. There is nothing associated with activity that would prevent or impair the use of this procedure as written, thus, it remains unaffected. The final procedure (AC 5.24, "Safety Management Programs") credits the hazardous material protection program with protecting workers from radiological and chemical hazards. This retrieval activity does not contain any activities or use any equipment that would limit the ability of this procedure to protect workers from releases. Therefore, Phase I retrieval of the liquid waste from SST 241-C-106 for closure does not adversely affect these procedures.

Flammable Gas Deflagrations—DST (Rep Acc 04):

Frequency of Occurrence: The FSAR, Section 3.4.2.2, states that without controls, a flammable gas deflagration in a DST headspace is an anticipated event. The HAZOP did not identify any instances where the slurry transfer would adversely affect any equipment in the receiver DST, creating spark sources or high temperature conditions. Thus, there are no unusual or unique ignition sources. Addition of the liquid waste will not change the properties of the waste such that gas generation rates would be increased beyond the worst case analyzed (HNF-SD-WM-CN-117, *Calculations of Hydrogen Release Rate at Steady State for Double-Shell Tanks*), which used a composite ULD for a radiological source term. Appendix A, Table A-13, shows that the ULDs for liquids or solids in either DST receiver tanks remains less than those for the nominal DST values used in the analysis. Appendix F lists the best-basis inventory (BBI) information used in this evaluation. The total organic carbon (TOC) concentrations in SST 241-C-106 are less than those reported for the DST receiver tank. Thus, with no increase in the radiological source term over that analyzed and no increase in the TOC, it is concluded that the flammable gas generation rate will not be significantly increased beyond that analyzed. For these reasons, there will be no significant increase in a flammable gas deflagration in the DST receiver tank. Furthermore, the slurry transfer will not create conditions for a flammable gas deflagration in the annulus beyond that already included in the accident analysis (misroutes and primary tank leaks). The transferred waste will not cause corrosion or other damage to the liner. If the pH in the receiver tank is lowered, a chemical adjustment may be required; however, this is not considered cause for concern of an impending primary tank leak to the annulus. For these reasons, it is concluded that this retrieval activity will not significantly increase the frequency of occurrence of an uncontrolled flammable gas deflagration in a DST.

The controls for this accident reduce the frequency of occurrence, thereby preventing the accident. The slurry transfer activity will not require any additional or revised controls beyond those normally credited with prevention of the accident. It is therefore concluded that the enhanced sluicing of SST 241-C-106 and transfer of waste slurries to DST 241-AY-102 will not significantly increase the frequency of occurrence of a flammable gas deflagration with controls in the DST.

Consequence: The accident analysis, FSAR, Section 3.4.2.2, does not provide a definitive analysis of the consequence of a flammable gas deflagration in a DST, as they were developed in a parametric manner to provide a perspective on the range of possible consequences and to relate consequences to various accident phenomena. Comparison of the DST ULD values (Appendix A, Tables A-10 and A-11) with those used in the accident analysis (FSAR,

Table 3.4.1-9) shows that the ULD values for the DST receiver tank is two orders of magnitude lower. There are no significant modifications to the tanks, nor are there any retrieval or transfer activities identified in the HAZOP sessions that would indicate a significant change in the amount of material that could be released in the event of a flammable gas deflagration. For these reasons, it is concluded that there will be no increase in the consequence of the flammable gas deflagration—DST analyzed accident.

Controls: There are three related safety-significant items of equipment important to safety associated with this accident: aging waste facility (AWF) primary tank ventilation systems, primary tank leak detection systems, and transfer leak detections systems. A liquid waste transfer into an AWF tank, within the normal parameters of pressure and flow, will not adversely affect the ventilation system such that there would be any degradation of its ability to prevent the accumulation of flammable gas. There would be no impact on the associated limiting condition for operation (LCO) (LCO 3.2.1, "DST and AWF Ventilation Systems") such that there would be any need for revision or exemptions.

The conditions in the receiver tank would not change sufficiently to affect any of the flammable gas generation parameters that would cause concern for the flammable gas monitoring frequency in the event the ventilation system is inoperable. The waste compatibility analyses in Blaak (1999), "Waste Compatibility Assessment of Tank 241-C-106 Waste (SST-99-07) with Tank 241-AY-102 Waste," reveal that flammable gas generation rates are well within the limits such that the time to reach the LFL in the event of active ventilation outages will not reach 25% of the LFL in < 7 days. In addition, there are no activities, facility modifications, or other conditions identified that would delay or preclude operability checks on the ventilation systems. Therefore, the bases for completion times for flammable gas monitoring and surveillance periods of LCO 3.2.1, "DST and AWF Tank Ventilation Systems," are unchallenged.

The primary tank leak detection is not affected by the waste transfer activities. The transfer will not degrade the ability of the conductivity probes, ENRAF[2] buoyancy-type instruments, and annulus ventilation stack continuous air monitor (CAM) to fulfill the function of leak detection and alarm. This equipment is designed to operate in the presence of tank waste or tank waste aerosols. This retrieval activity will not change the waste form in any way other than dilution with raw water. LCO 3.2.6 remains unaffected as there is no activity or tank modification that would prevent operability checks on the system. The surveillance frequencies for flammable gas monitoring in the event of a malfunction or alarm remain unchanged and the restoration period also remains unchanged as the supporting calculations (HNF-SD-WM-CN-117) are based on a conservative gas generation rate.

The transfer leak detection system is not affected by the waste transfer activities. The leak detection equipment is designed to work in a typical tank waste environment. The retrieval and subsequent transfer activities will not involve any activity that would damage or otherwise affect a leak detection system such that it would not be able to detect the presence of waste in the structure. LCO 3.1.3, "Transfer Leak Detection Systems," remains unaffected by this

[2] Enraf-Nonius™ Series 854 is a trademark of Enraf-Nonius Corporation, Netherlands.

retrieval activity. The transfers remain within the limits of the waste leak analysis; therefore, there is no effect on action times or surveillance frequencies.

The requirements for AC 5.9, "Flammability Controls," are not affected by this retrieval activity for the following reasons: The waste compatibility analyses (Blaak 1999) indicate that there will be no change in facility group for DST 241-AY-102 upon completion of transfer of the waste from SST 241-C-106. There are no changes to transfer associated structures such that there would be any changes in the ventilation air exchange rate. The transfers are not prohibited by this AC nor do they involve transfers into or from a double-contained receiver tank.

The requirements from AC 5.10, "Ignition Controls," remain unaffected for this retrieval activity for the following reasons: (1) there will be no additional equipment installed in the receiver DST; (2) all currently installed equipment meets all ignition control requirements; and (3) there are no activities that would modify or otherwise change this equipment in any way that would affect the ability to meet ignition source requirements.

The requirements from AC 5.11, "Flammable Gas Monitoring Controls," remain unaffected. Continuous monitoring is not required during the unmanned transfer. There are no modifications or other activities that would prevent or otherwise affect the ability to monitor flammable gas concentrations in the DST receiver tank.

There is one requirement in the waste compatibility controls from AC 5.12, "Transfer Controls," applicable to the flammable gas deflagration accident. This control states that the minimum time to reach 25% of the LFL for the tank vapor space (assuming loss of the primary tank ventilation) will remain $\geq$ 7 days. The waste compatibility analyses (Blaak 1999) reveal that flammable gas generation rates are well within the limits such that the time to reach the LFL in the event of active ventilation outages will not reach 25% of the LFL in < 7 days.

AC 5.14, "Emergency Preparedness," is included within the suite of controls to mitigate the results of a flammable gas deflagration. This retrieval activity will not impede or otherwise cause problems in implementing emergency response procedures or actions. This control requires no changes or modifications as a result of enhanced sluicing of SST 241-C-106 and subsequent slurry transfers into the receiver DST.

There are no modifications to the DST receiver tank ventilation systems nor anything in the retrieval using enhanced sluicing of SST 241-C-106 and subsequent slurry transfers that would adversely affect AC 5.18, "HEPA Filter Controls." There is no activity that would interfere with measuring the radiation levels replacing HEPA and high-efficiency gas adsorber filters. The major requirement is that the HEPAs and other filters have administrative limits on the source terms such that the direct reading of radiation levels of the installed HEPA housing must be $\leq$ 2.0 E-03 Sv/h ($\leq$ 200 mrem/h) on contact. This protects the source-term assumptions used in the accident analysis. The readings measure gamma radiation, the principal contributor being ^{137}Cs. The cesium concentration in the DST receiver tank would remain relatively constant; thus, the amount of entrained cesium would not change sufficiently to invalidate the assumption that the total dose is proportional to the cesium contribution. Controls associated with the flammable gas deflagration accident require use of process instrumentation, e.g., CAMs and radiation monitors. Because of this, AC 5.19, "Process

Instrumentation and Measuring and Test Equipment," is relied upon to provide assurance that equipment used to measure process parameters is properly maintained. Retrieval of the liquid waste from SST 241-C-106 following sluicing of the sludge will not modify or otherwise change process instrumentation such that it cannot be calibrated, checked, or otherwise maintained; thus, there is no adverse effect on this control.

Waste accumulation in waste transfer-associated structures creates flammable gas hazards. As a preventive measure, AC 5.20, "Transfer Pump Administrative Lock Controls," is applied to reduce the possibility of waste leakage accumulating in waste transfer-associated structures, thereby preventing flammable gas hazards from developing within the structures. The design of the transfer pumps does not prevent placing an administrative lock on the pump nor are there any changes to other pumping equipment. For these reasons, this control is unaffected and remains valid.

Flammable Gas Deflagrations—SST (Rep Acc 05):

Frequency of Occurrence: The frequency of occurrence of a flammable gas deflagration in an SST that does not result in dome collapse is considered an "anticipated" event (F3). The basis for this assumes that the gas generation rate is sufficient to reach the lower flammability limit. The gas generation rate for SST 241-C-106 was greatly reduced after removing most of the waste by past-practice sluicing. It is estimated that there is insufficient waste remaining in the tank to produce a flammable atmosphere with passive breathing (RPP-13547, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere*). Thus, the frequency of occurrence for this tank would be considered "unlikely" (F2); therefore, there is no increase in the frequency of occurrence for the flammable gas deflagrations analyzed accident.

Consequence: The consequence of a flammable gas deflagration is based on the release of SST solids. Enhanced sluicing does not involve addition of waste from another tank as did the previous retrieval using past-practice sluicing. Thus, there would be no additional solids introduced. The process wets the solids with raw water and/or the supernatant and forms a slurry. A wet solid or slurry, as opposed to the dry solids found in many of the SSTs, is less likely to be entrained in air as a result of a deflagration. For these reasons, it is concluded that the consequence of a flammable gas deflagration in SST 241-C-106 during retrieval of the liquid waste following sluicing of the sludge will not be significantly increased.

Controls: The flammable gas deflagration hazardous conditions related to the enhanced sluicing of SST 241-C-106, identified in the HAZOP, were assigned a frequency of occurrence of "unlikely" (F2). This was based on the engineering study concluding that there was insufficient flammable gas generation to reach the LFL (RPP-13547). Consideration of application of controls is required as established by the FSAR, Table 3.3.1.5-2, Risk Matrix. The control decision record (Appendix D) shows the controls allocated to the hazardous conditions related to flammable gas deflagrations in SST 241-C-106. The following paragraphs provide a discussion of how retrieval of the waste using enhanced sluicing affects these controls.

There are two related items of equipment important to safety associated with this accident: SST tank ventilation systems and transfer leak detections systems. The transfer leak detection

system was discussed in the previous evaluation of a flammable gas deflagration in a DST and need not be evaluated further. The planned sluicing activity will rely upon an active ventilation system to remove fog so that the sluicing can be observed using remote video cameras. A variable damper system is installed to adjust inlet flow to ensure a minimum negative pressure gradient in the tank vapor space. There is no technical basis for the need for active ventilation based upon the flammable gas generation analysis (RPP-13547). This evaluation concluded the tank vapor space will not reach the flammability limit with barometric breathing only. Thus, the active ventilation system serves the purpose of reducing fog to increase visibility and is not required to reduce flammable gas concentrations in the vapor space. LCO 3.2.3, "SST Ventilation Systems—Passive," is applicable to SST 241-C-106. Passive ventilation is sufficient to prevent flammable gas accumulations above the LFL.

A blanket statement in the FSAR, Section 4.3.4, states that SST passive and active ventilation systems are safety-class structures, systems, and components (SSC). The safety classification of the active ventilation system for enhanced sluicing would be considered general service considering the low gas generation rate coupled with the dual (passive and active) ventilation system; however, the passive ventilation system would be considered a safety-class SSC. Thus, for flammable gas purposes, LCO 3.2.2 is not applicable. LCO 3.2.3, "SST Ventilation Systems—Passive," is applicable and precludes flammable gas accumulation above the LFL (RPP-13547).

The requirements for AC 5.9, "Flammability Controls," are not affected by this retrieval activity for the following reasons. The flammable gas generation analysis (RPP-13547) provides assurance that the current facility grouping for SST 241-C-106 is adequate. Further evaluation may conclude that this tank could be grouped with the non-gas release event tanks; however, this change would require a safety basis amendment.

The requirements from AC 5.10, "Ignition Controls," remain unaffected for this retrieval activity for the following reasons: (1) the installed equipment meets all ignition control requirements; and (2) there are no activities that would modify or otherwise change other equipment in any way that would affect the ability to meet ignition source requirements.

The requirements from AC 5.11, "Flammable Gas Monitoring Controls," remain unaffected. Access to the areas for required monitoring remains available during installation and operation. There is no modification to the tank structure or equipment installation that would cause any indication that monitoring activities or instrumentation would not work as intended. Therefore, it is determined that retrieval of the liquid waste in SST 241-C-106 following sluicing of the sludge would not prevent flammable gas monitoring requirements from being implemented. Thus, AC 5.11 remains valid as currently approved. Sluicing is considered a global waste disturbing activity and would require periodic monitoring, established in the control decision meeting conservatively as daily.

AC 5.14, "Emergency Preparedness," is included within the suite of controls to mitigate the results of a flammable gas deflagration. This retrieval activity will not impede or otherwise cause problems with emergency response procedures or actions. This control requires no changes or modifications as a result of sluicing of SST 241-C-106 sludge and subsequent transfers of liquid waste into the receiver DST.

There are no modifications to the SST 241-C-106 ventilation systems (either passive or active), nor any activities associated with the sluicing and subsequent liquid waste transfers, that would adversely affect AC 5.18, "HEPA Filter Controls." There is no activity that would interfere with measuring the radiation levels or replacing filters. The major requirement is that the HEPAs and other filters have administrative limits on the source terms such that the direct reading of radiation levels of the installed HEPA housing must be $\leq$ 2.0 E-03 Sv/h ($\leq$200 mrem/h) on contact. This protects the source-term assumptions used in the accident analysis. The readings measure gamma radiation, the principal contributor being ^{137}Cs. The cesium concentration derived from the BBI (Appendix A, Tables A-1 and A-2) shows that the ^{137}Cs content is 5.36 E+04 μCi/L in the supernatant and 4.96 E+05 μCi/L in the sludge. Thus, the cesium concentration in the vapor space would remain relatively constant during sluicing and liquid waste transfers, indicating that the ability to measure contamination levels on the filters using ^{137}Cs as the benchmark remains valid. Thus, it remains possible to measure contamination on the filters using gross gamma readings and AC 5.18 remains valid.

Controls associated with the flammable gas deflagration accident require use of process instrumentation, e.g., CAMs and radiation monitors. Because of this, AC 5.19, "Process Instrumentation and Measuring and Test Equipment," is relied upon to provide assurance that equipment used to measure process parameters is properly maintained. Retrieval of the liquid waste from SST 241-C-106 following sluicing of the sludge will not modify or otherwise change process instrumentation such that it cannot be calibrated, checked, or otherwise maintained; thus, there is no adverse effect on this control.

The discussion concerning AC 5.12, "Transfer Controls," as applicable to the flammable gas deflagration accident is listed last. This is because the requirement related to transfers from an SST states that controls for flammable gas deflagrations remain valid upon completion of the transfer. The above discussions on the TSR controls for a flammable gas deflagration in an SST all conclude that they are valid; therefore, the requirements of AC 5.12 are met.

HEPA Filter Failure—Exposure to High Temperature or Pressure (Rep Acc 06):

Frequency of Occurrence: A review of the hazard analysis database found that the hazardous conditions related to this analyzed accident are analogous to those in the hazard analysis database assigned to the analyzed accident. Thus, the analysis of HEPA filter failure—exposure to high temperature or pressure accident is valid for this activity. The frequency of occurrence without controls for the analyzed accident is listed as "anticipated" (F3) in FSAR, Table 3.3.2.4.2-3. The only high temperature hazardous condition involves a fire near the HEPA filter such as would be caused by a vehicle fuel tank rupture and subsequent fire. This hazardous condition is identical to all vehicle-related accidents and therefore would not relate to an increase of the frequency of occurrence for this accident. Hazardous conditions related to retrieval of the waste in SST 241-C-106 for closure were, for the most part, also considered to be anticipated.

Aerosol generation and moisture buildup causing HEPA filter failure has been identified as documented in FSAR Appendix C, Table C-2, and the hazard analysis database. These are the two principal HEPA filter failure mechanisms identified for retrieval of the liquid waste in SST 241-C-106 for closure. This transfer activity is not significantly different from any other transfer such that in-tank spray leaks, in and of themselves, would cause an increase in the frequency of occurrence of a HEPA filter failure. The analysis for this accident (HNF-SD-WM-CN-099, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*) involves disturbed waste analogous to sluicing (e.g., mixer pump operation and past-practice sluicing). The potential aerosol/moisture generation and entrainment into the ventilation system caused by the sluicing of the sludge in SST 241-C-106 and following liquid transfers into the DST receiver tank are similar in nature to what has been analyzed. Thus, with no new types of HEPA failure initiators and the aerosol/moisture generation mechanisms similar to that currently in the FSAR accident analysis, it is concluded that retrieval of the liquid waste in SST 241-C-106 for closure will not increase the frequency of occurrence of the HEPA filter failure—exposure to high temperature or pressure accident.

Consequence: The consequences for the analyzed accident for a HEPA filter failure caused by exposure to high temperature or pressure are below offsite evaluation guidelines, but do exceed onsite evaluation guidelines (S2) as presented in FSAR, Table 3.3.2.4.2-3 and Table 3.3.2.4.2-4. Hazardous conditions related to this activity were assigned safety consequence of S2, or affecting the onsite (co-located worker), as documented in the control decision record. The analysis for this accident (HNF-SD-WM-CN-099) involves disturbed waste analogous to sluicing (e.g., mixer pump operation and past-practice sluicing). This calculation uses a partition fraction (aerosols) of 10-8 for both mixer pump operation and sluicing. Thus, the release calculation for mixer pump operation (HNF-SD-WM-CN-099, Attachment 8) is a valid comparison for the sluicing operations in SST 241-C-106. The major variable in the analysis that needs to be considered is the ULD. From the release calculation (HNF-SD-WM-CN-099, Attachment 8) used in the accident analysis, the aerosols and HEPA filter loading is considered to be 10% solids and 90% liquids. Using the BBI presented in Appendix A, the onsite ULD for accidents involving the waste in SST 241-C-106 is 2.30 E+01 Sv/L for the liquid and 2.93 E+04 for the sludge. Thus, the SST 241-C-106 ULD, based on the 10-90 solid-liquid ratio, computes to 2.92 E+03 Sv/L. The calculation for the accident analysis lists an inhalation ULD

of 1.7 E+05 Sv/L (HNF-SD-WM-CN-099). The calculations are all linear equations; therefore, a computation of the consequence of sluicing of SST 241-C-106 can be estimated by a simple proportion to the ULDs. The ratio of SST 241-C-106 to those used in HNF-SD-WM-CN-099, Attachment 8 of the calculation note is 0.017; thus, the consequences shown in the calculation, when multiplied by this ratio, reflect the consequences of a HEPA filter failure for SST 241-C-106. Table 4-1 shows the comparison of the consequence for HEPA filter failure. In all cases, the consequence for sluicing of SST 241-C-106 remains below the value shown in the FSAR. This analysis is conservative, insofar as each sluice/transfer cycle will reduce the amount of waste that can be mobilized (especially the liquid phase), as such the headspace aerosol ULD will be lessened as the retrieval proceeds.

Table 4-1. Unmitigated Consequence of a HEPA Filter Failure—Exposure to High Temperature or Pressure for Sluicing of SST 241-C-106.

Receptor	Event	Mixer pump consequence analysis[1] (Sv)	241-C-106 enhanced sluicing[4] (Sv)	Analyzed accident[5] (Sv)
Onsite	High Temperature	2.5 E-01 (12 hr)	4.25 E-03	5.9 E-03
	Overpressure	3.2 E-01 (12 hr)[2]	5.44 E-03	5.3 E-02
	Wetting	2.5 E-01 (12 hr)[3]	4.25 E-03	—
Offsite	High Temperature	3.5 E-04 (24 hr)	5.95 E-06	8.5 E-06
	Overpressure	4.0 E-04 (24 hr)[2]	6.80 E-06	4.9 E-05
	Wetting	3.5 E-04 (24 hr)[3]	5.95 E-06	—

Notes:

[1] Excerpted from Attachment 8, Table 2 of HNF-SD-WM-CN-099, *Radiological and Toxicological Analyses of Tank 241-AY-102 and Tank 241-C-106 Ventilation Systems*, Rev. 1E, Fluor Daniel Northwest, Inc., Richland, Washington.

[2] Includes only effects due to releases from ventilation system followed by unfiltered release from headspace through failed filter. Effects due to initiating event (e.g., flammable gas deflagration) must be added to obtain total consequences.

[3] Continuous release doses (uniform over 12 hr onsite and 24 hr offsite) can be extrapolated to annual average doses by multiplying by 15.2 and 9.0 for the onsite and offsite receptors, respectively.

[4] Calculated by multiplying the mixer pump consequence by the ratio of the unit-liter doses (mixer pump analysis/241-C-106, which equals 0.017).

[5] Excerpted from Tables 3.3.2.4.2-3 and 3.3.2.4.2-9 of HNF-SD-WM-SAR-067, *Tank Farms Final Safety Analysis Report*, Rev. 3H, CH2M HILL Hanford Group, Inc., Richland, Washington.

HEPA = high-efficiency particulate air (filter).
SST = single-shell tank.

The transfer of waste generates waste in the receiver DST. The partition fraction (aerosolized waste) can be equivocated to either sluicing or mixer pump operation, so the comparison to the analysis in HNF-SD-WM-CN-099, Attachment 8, is valid. From Appendix A of this report, the 10% solid-90% liquid onsite ULDs after retrieval for DST 241-AY-102 is 3.09 E+03 Sv/L, respectively. This is below the ULD in the analysis and would therefore result in releases lower than the analysis. Thus, the HEPA filter failure consequences for sluicing of SST 241-C-106 and subsequent slurry transfer is shown to have consequences lower than the HEPA filter failure—exposure to high temperature or pressure analyzed accident.

Controls: There are two safety-significant items of equipment important to safety associated with this accident: ventilation stack CAM interlock systems and HEPA filters. The HEPA filters are only applicable to the 244-AR Vault system. The activities associated with retrieval of the waste in SST 241-C-106 for closure will not directly affect the CAM interlock systems. There is no interaction between the CAM interlock with the equipment for sluicing, so there would be no effect on the performance of the CAM interlock for the SST 241-C-106 ventilation system. Transfers into a DST are a normal operation; therefore, the additional solids content of a supernatant transfer would have no effect on the CAM interlock system for the DST ventilation. Because there would be no effect on the CAM interlock system, it follows that there is no adverse effect or required revisions to LCO 3.1.4, "Ventilation Stack CAM Interlock Systems" (HNF-SD-WM-TSR-006).

AC 5.18, "HEPA Filter Controls," is also credited for this accident. For retrieval of the liquid waste in SST 241-C-106 for closure, the HEPA filter source-term requirements of AC 5.18 are applicable. The major requirement is that the HEPA filters and other filters have administrative limits on the source terms such that the direct reading of radiation levels of the installed HEPA filter housing must be $\leq$ 2.0 E-03 Sv/h ($\leq$ 200 mrem/h) on contact. This protects the source-term assumptions used in the accident analysis. The readings measure gamma radiation, the principal contributor being ^{137}Cs. The cesium concentration in the DST receiver tank would remain relatively constant. Consequently, the amount of entrained cesium would not change sufficiently to invalidate the assumption that the total dose is proportional to the cesium contribution. The cesium concentration derived from the BBI (Appendix A, Tables A-1 and A-2) shows that the ^{137}Cs content in SST 241-C-106 is 5.36 E+04 μCi/L in the supernatant and 4.96 E+05 μCi/L in the sludge. Thus, the cesium concentration in the vapor space would remain relatively constant during sluicing and liquid waste transfers, indicating that the ability to measure contamination levels on the filters using ^{137}Cs as the benchmark remains valid. Thus, it remains possible to measure contamination on the filters using gross gamma readings and AC 5.18 remains valid. The final control associated with HEPA filter failure—exposure to high temperature or pressure is AC 5.19, "Process Instrumentation and Measuring and Test Equipment." For this accident, the CAMs and CAM interlock system plus the HEPA filter radiation monitoring equipment are all that are affected. Retrieval of the liquid waste in SST 241-C-106 for closure activities will have no adverse effect on this equipment or the equipment used for calibration and maintenance; therefore, this control remains valid without any changes or restrictions.

Fire in Contaminated Area (Rep Acc 07):

Frequency of Occurrence: A review of the hazard analysis database found that the hazardous conditions assigned to this analyzed accident are similar in nature and the analyzed accident is a valid analysis. The frequency of occurrence without controls for the analyzed accident is listed as "anticipated" (F3) in FSAR, Table 3.3.2.4.3-1. The highest frequency hazardous condition related to this activity was determined to be "anticipated" (F3). The anticipated hazardous condition identified with retrieval of the waste in SST 241-C-106 for closure is rupture of a vehicle fuel tank and subsequent fire in a contaminated area. This hazardous condition is analogous to that analyzed in the FSAR. Because the conditions are the same, the frequency of occurrence for this accident remains unchanged.

Consequence: The consequence for this analyzed accident, as listed in FSAR, Table 3.3.2.4.3-1, exceeds the onsite release radiological and toxicological evaluation guidelines but does not exceed those for offsite releases. The accident analysis uses a 67 vol% AWF fluid/ 33 vol% AWF solid slurry as the material at risk (MAR) with an onsite ULD of 5.65 E+05 Sv/L (Appendix A, Table A-13). Conservatively, a waste transfer leak of SST 241-C-106 slurry would create a contaminated area with an onsite ULD for the slurry would be 9.68 E+03 Sv/L. This is approximately two orders of magnitude less than that for the analyzed accident. The ULD affects the release consequence linearly; thus, the smaller ULD reflects a smaller consequence compared to the analyzed accident.

Controls: There are two controls assigned to this accident. AC 5.10, "Ignition Controls," is relied upon as a preventive measure, specifically the vehicle controls. This requires that fuel tanks be protected against damage, and traffic route controls and barricades be placed to prevent vehicles from striking risers and other aboveground structures. The installation of equipment and subsequent retrieval activity do not contain requirements nor is there any condition that would prevent the vehicle controls of AC 5.10 to be fully implemented.

AC 5.14, "Emergency Preparedness," is included within the suite of controls to mitigate the results of a fire in a controlled area. This retrieval activity will not impede or otherwise cause problems with emergency response procedures or actions. This control requires no changes or modifications as a result of sluicing of SST 241-C-106 sludge and subsequent transfers of liquid waste into the receiver DST. Consequently, it is concluded that retrieval of the waste in SST 241-C-106 for closure will not adversely affect these procedures associated with the fire in contaminated area analyzed accident.

Organic Solvent Fire (Rep Acc 09):

Frequency of Occurrence: Two hazardous conditions (C106PHASE-1-H-05 and C106PHASE-1-H-06) were identified; however, the frequency of occurrence was determined to be "beyond extremely unlikely" based on the retrieval method that sluicing would not introduce organic solvents, plus the wet conditions would not create ignition sources. SST 241-C-106 is not listed in the analyzed accident as containing sufficient organic solvents to initiate the accident; therefore, it is determined that there is no effect on the frequency of occurrence for this accident.

Consequence: There is no waste addition to SST 241-C-106. In fact, as the retrieval proceeds, the MAR will be reduced significantly as compared to other SSTs or the DSTs; therefore, there would be no increase in the consequence of an organic solvent fire in that tank. Table 5-1 from the release analysis for this accident (WHC-SD-WM-CN-032, *Analysis of Consequences of Postulated Solvent Fires in Hanford Site Waste Tanks*) lists the radiological input data to the analysis. Table 4-2 provides a comparison of the radiological information used in the analysis to that provided in Appendix A. In all cases, the values of the ULDs for SST 241-C-106 and the receiver DST are much smaller than those used in the analysis. It is concluded that retrieval of the liquid waste in SST 241-C-106 for closure following sluicing, the sludge will not increase the consequence of the organic solvent fire analyzed accident.

Table 4-2. Comparison of Unit-Liter Dose as Related to the Organic Solvent Fire Analysis.

Tank	Liquids			Solids		
	ULD[1] actual (Sv/L)	ULD analysis (Sv/L)	Ratio actual/ analysis	ULD[1] actual (Sv/L)	ULD analysis (Sv/L)	Ratio actual/ analysis
241-C-106	2.30E+01	1.10E+04[2]	0.002	2.93E+04	2.20E+05[2]	0.133
241-AN-106 after retrieval	2.06E+01	6.10E+03[2]	0.003	8.89E+03	1.00E+05[3]	0.089
241-AY-102 after retrieval	1.37E+01	1.04E+03[2]	0.013	3.08E+04	1.72E+05[3]	0.179

Notes:

[1] The ULD actual is derived from the information provided in Appendix A.

[2] The ULD analysis for the organic solvent fire accident is excerpted from Table 5-1 of WHC-SD-WM-CN-032, 1998, *Analysis of Consequences of Postulated Solvent Fires in Hanford Site Waste Tanks*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[3] The ULD for DST and AWF solids were not listed in the FSAR accident analysis, WHC-SD-WM-CN-032. For the purpose of comparison, ULD analysis values were excerpted from Table 4-5 of RPP-5924, 2002, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

AWF = aging waste facility.
DST = double-shell tank.
FSAR = Final Safety Analysis Report.
ULD = unit-liter dose.

Controls: There is no equipment important to safety credited with mitigation or prevention of the organic solvent fire analyzed accident; however, there are four administrative controls listed for this accident. Of those, AC 5.10, "Ignition Controls," is relied upon as a preventive measure for those key elements concerning lightning, flame cutting/welding and equipment installation, and vehicle controls. The activities associated with installation of equipment, sluicing, and then transfer of the liquid waste from SST 241-C-106 can be accomplished within the restrictions of the lightning controls with no reservations or restrictions. Likewise, the controls for cutting/welding and equipment installation can also be met. Finally, the vehicle controls (fuel tanks to be protected against damage and traffic route controls and barricades to be placed to prevent vehicles from striking risers and other aboveground structures) are easily met with no restrictions or reservations. Thus, installation of equipment and subsequent retrieval activity do not contain requirements nor is there any condition that would prevent implementation of those key elements of AC 5.10.

Natural Phenomena – High Wind (Rep Acc 10):

Frequency of Occurrence: Retrieval of the liquid waste in SST 241-C-106 requires removal of some existing long-length equipment. The wind-related hazardous condition is related to wind damage to the flexible receiver and subsequent release of tank waste. The frequency of occurrence for the analyzed accident for wind damage to a flexible receiver is "anticipated" (F3). Except for the specificity of the hazardous condition (removal of long-length equipment from SST 241-C-106), this hazardous condition is identical to the accident analysis scenario. Thus, the frequency of the hazardous condition is established as "anticipated" (F3), the same as the analyzed accident.

Consequence: The analyzed accident is based on a release of 3 gal of tank waste, which does not exceed evaluation guidelines for an onsite release. That is considerably less than the potential holdup of approximately 40 gal of waste that could be contained in the heel jet pump as it is removed. Thus, the consequence of this analyzed accident is increased and may potentially exceed evaluation guidelines. The consequence of this condition was evaluated in the safety evaluation report (SER) (Schepens 2002) and found to potentially exceed onsite guidelines.

Controls: Because the specific conditions for removal of the heel pump from SST 241-C-106 may exceed evaluation guidelines, additional controls were required by the SER (Schepens 2002), specifically:

The receiver bag to be used for the heel pump will be designed and constructed of material of sufficient strength to contain the MAR resulting from postulated failures of equipment (i.e., the heel pump flexible hose and 590 lb of waste). The design and material of the receiver bag as described by H-2-79350, "TWRS 70' Flexible Receiver Bag Assy for 42" Riser," will be verified by mock-up testing. To ensure receiver bags have not degraded during storage, the receiver bag used shall have been in storage < 7 yr and protected from ultraviolet light.

Tank Failure due to Excessive Loads (Rep Acc 12b):

Frequency of Occurrence: The frequency of occurrence for the analyzed accident was found to be an "unlikely" (F2) event based on multiple yearly lifts of large mixer pumps. This was established using a frequency of occurrence of a load drop over a range of 2.5×10^{-5} to 3×10^{-4} per lift. The hazardous condition identified for retrieval of the liquid waste from SST 241-C-106 is associated with removal of the heel jet pump, a single activity. Thus, the established frequency of occurrence for a single lift is appropriate. Therefore, the established frequency of occurrence for this particular hazardous condition (ID No. C106PHASE-1-A-13) of "unlikely" (F2) is a conservative value and does not increase the frequency of occurrence for the analyzed accident.

Consequence: The analyzed accident found that the consequence of dropping a mixer pump exceeded the onsite evaluation guidelines but did not exceed the offsite limits. The damage from a high lift of the heel jet pump would be similar. The lifting activity was subject to a USQ evaluation (for this particular lift, USQ No. TF-03-0001). Among the conclusions, the USQ evaluation identified that the lift height exceeds the boundary of the accident analysis. The consequence of this particular condition was evaluated in the SER (Schepens 2002) and found to be within the bounds of the analyzed accident.

Controls: AC 5.16, "Load Lifting and Dome Loading Controls," is credited for prevention of this accident. The controls for removal of the heel jet pump were evaluated in the SER (Schepens 2002) and found to be inadequate. The following controls specific to removal of long-length equipment from SST 241-C-106 were required as part of the approval to remove this equipment:

- AC 5.16.2a.2 is applicable; it states, "For mechanically lifted loads within 20 ft of SSTs (100 Series), DSTs, and AWF tanks, the lower equipment boundary of the lifted item

(e.g., bottom of the cover block, thermocouple tree) shall be < 20 ft above surface grade, or pit floor above a WASTE storage tank (covered or uncovered)."

- Critical lift procedures shall be used for removal of the heel pump and transfer pump from SST 241-C-106. The critical lift procedure shall not allow lifting in wind speeds that exceed 15 mi/h.

- The WSSP-1 packaging container will be positioned such that the minimum distance from the edge of any waste tank to the container is at least equal to the length of the pump being lifted.

Tank Failure due to Vacuum or Degradation (Rep Acc 13):

Frequency of Occurrence: This accident is covered under the analyzed accident, tank failure due to excessive loads. Included in this analysis is tank failure caused by excessive vacuum caused by (1) failures in the ventilation system with continued exhaust operation; (2) cool down after certain accidents (e.g., fire); or (3) cooling of the atmosphere or waste as the result of the addition of water as listed in FSAR, Section 3.4.2.1. The accident analysis found that a vacuum of 8 lb/in^2 is required to damage a waste tank. The active ventilation system in SST 241-C-106 does not have the ability to produce the 8 lb/in^2 of vacuum required for tank failure (RPP-13222). The frequency of these hazardous conditions, as listed in FSAR, Appendix C, is identified as "extremely unlikely" (F1) or "beyond extremely unlikely" (F0). The tank failure due to excessive vacuum hazardous conditions identified for retrieval of the waste in SST 241-C-106 for closure are similar in nature to those found in FSAR, Appendix C; all have the same F1/F0 frequency of occurrence. The ventilation system for the primary receiver DST or alternate DST remains unchanged by this activity. Currently, these systems do not have the ability to create vacuum-induced tank damage. Subsequently, it is concluded that the frequency of occurrence for this analyzed accident remains unchanged.

Consequence: The accident uses a source term of dry saltcake as the bounding MAR. Retrieval of the liquid waste in SST 241-C-106 for closure involves sluicing to mobilize sludge which, being moist, would not be released in appreciable amounts. The additional waste from SST 241-C-106 in receiver DST will increase the source term ULD for the liquids because the ULDs in the source tank are greater than for either receiver tank as shown in Appendix A. However, when compared to the bounding DST and AWF values presented in Appendix A, Table A-13, these values remain much less. For these reasons, it is concluded that sluicing of SST 241-C-106 and following liquid transfer to the AWF receiver tank DST 241-AY-102 will not increase the consequence of tank failure due to vacuum or degradation.

Controls: There are no TSR-level controls identified to either mitigate or prevent this accident. There are several defense-in-depth (DID) controls identified in the FSAR, Table 3.4.2.1-5. Of these, only one DID control is specific to excessive vacuum conditions in the tank. This specific DID control is the tank pressure monitors and/or alarms that provide indication of potential tank failure due to excessive vacuum or pressure conditions. There is no planned modification to the tank or equipment installation that would interact or cause a problem with monitoring the tank vapor space pressure in either SST 241-C-106 or DST 241-AY-102. The hazardous conditions identified for this retrieval activity do not require TSR-level controls because of the low frequency of occurrence.

Tank Bump (Rep Acc 18A):

Frequency of Occurrence: A review of the hazard analysis database found that the hazardous conditions assigned to this analyzed accident reflect the conditions in tanks with high heat loads. The tank bump-related hazardous conditions identified for enhanced sluicing of SST 241-C-106 are related to the past-practice sluicing as documented in a previous revision of the FSAR, Rev. 3-C. The frequency of occurrence without controls identified in Addendum 1 to the FSAR, Rev. 3-C is listed as "anticipated" in Table 3.4.2.11-1. These tank bump hazardous conditions for the enhanced sluicing activities for retrieval of the waste in SST 241-C-106 for closure were found to be "beyond extremely unlikely" (F0) because of the limited amount of waste remaining in the tank. This is documented in the accident analysis, FSAR, Rev. 3-D, Section 3.4.2.11, which removes SST 241-C-106 from consideration for this accident because the supernatant depth is < 3 ft. The heat load in primary receiver tank, DST 241-AN-106, including the waste transferred from SST 241-C-106, is estimated to be 7,300 BTU/h (RPP-13707, *Process Control Plan for Tank 241-C-106 Closure*). This is well below the 29,000 BTU/h limit established in the accident analysis where tank bump is a concern. For the alternate receiver tank, DST 241-AY-102, the small amount of additional waste will not change the heat loading such that a tank bump would be imminent; thus, the anticipated frequency of occurrence in that tank is not challenged. The controls for this accident are preventive in nature; however, this retrieval activity has no adverse effect on the controls as discussed below, and therefore could not affect the frequency of the controlled accident. Consequently, it is concluded that retrieval of the waste in SST 241-C-106 for closure will not increase the frequency of occurrence of the tank bump accident.

Consequence: The consequence of the analyzed tank bump accident is shown to exceed the onsite radiological and toxicological evaluation guidelines as documented in FSAR, Table 3.4.2.11-2. Offsite evaluation guidelines are not challenged. The only tank of concern where a tank bump is considered is the alternate receiver tank, DST 241-AY-102. The diluted waste from enhanced sluicing of SST 241-C-106 does not increase the concentration of the MAR, because the tank already contains most of that waste, plus the addition is diluted by large amounts of raw water as shown in the ULD tables in Appendix A. Therefore, it is concluded that retrieval of the waste in SST 241-C-106 for closure will not increase the consequence of the tank bump accident.

Controls: Two safety-significant items of equipment important to safety are credited for this analyzed accident: the temperature monitoring systems in the DSTs and AWFs, and the DST 241-AY-102 annulus ventilation system. Transfer of waste from SST 241-C-106 into DST 241-AY-102 would not be significantly different from any other waste transfer and, accordingly, would not adversely affect this equipment, including any of the provisions for the temperature controls, LCO 3.3.2, "DST and AWF Tank WASTE Temperature Controls," and LCO 3.3.3, "Tank 241-AY-102 Annulus Ventilation System" (HNF-SD-WM-TSR-006). One additional administrative control is credited for this analyzed accident, AC 5.19, "Process Instrumentation and Measuring and Test Equipment." This control ensures that the temperature monitoring instrumentation is maintained. Retrieval activities associated with closure of SST 241-C-106 would not affect this control in any way.

Unfiltered Release (Rep Acc 18B):

This accident is analyzed as a part of the HEPA filter failure—exposure to high temperature or pressure (Rep Acc 06) analyzed accident discussed above.

Mixing of Incompatible Material—Toxic Vapor Generation (Rep Acc 23):

Frequency of Occurrence: A review of the hazard analysis database found that the hazardous conditions associated with this analyzed accident are similar in nature to existing hazardous conditions, and thus the analyzed accident is a valid analysis for this postulated accident. The frequency of occurrence without controls for the analyzed accident is listed as "anticipated" (F3) in FSAR, Table 3.3.2.4.11-1. The frequency of occurrence of hazardous conditions related to this retrieval activity were determined to be "beyond extremely unlikely" (F0) based on the analysis documented in RPP-13707 indicating that these proposed transfers would not react with the waste in the receiver tank. Therefore, it can be concluded that the activity would not create a situation where toxic vapor is generated; subsequently, there is no effect or increase on the frequency of occurrence of this analyzed accident. There are no TSR-level controls for this accident, so the mitigated frequency does not have to be evaluated. It is concluded that this activity would not increase the frequency of occurrence of this analyzed accident.

Consequence: The analyzed accident in FSAR, Table 3.3.2.4.11-1, shows that the toxicological sum of fractions is below evaluation guidelines and thus would only affect the facility worker. Because releases from transfer of the liquid waste in SST 241-C-106 to DST 241-AY-102 were shown to be insignificant insofar as reaction of tank waste (Reynolds 2001), it is concluded that this activity will not increase the consequence of this accident.

Controls: The analyzed accident does not rely upon any TSR-level or DID controls. The low frequency of occurrence for the hazardous conditions specific to retrieval of the waste in SST 241-C-106 for closure does not require controls.

Waste Transfer Leak into Structure; Soil Surface or into Atmosphere; or Due to Misroute (Rep Acc 33A, 33C, and 33D):

Frequency of Occurrence: A review of the hazard analysis database found that the hazardous conditions assigned to this analyzed accident are analogous to hazards in the hazard analysis database for the waste transfer leak accidents. Thus, the analyzed accident for waste transfer leaks is valid for this activity. The frequency of occurrence without controls for the analyzed accident is listed as "anticipated" (F3) in FSAR, Table 3.3.2.4.7-1. The frequency of occurrence for hazardous conditions related to this activity was determined to be "anticipated" (F3). This activity involves transfer of waste liquids from SST 241-C-106 to DST 241-AY-102. The supernatant transfer pump is rated to deliver about 125 gal/min at 52 lb/in^2 (normal operating point) with a maximum shutoff (no flow) pressure of 64 lb/in^2 (see Figure 2-4). This is well below the maximum working pressure of the HIHTL and the compliant underground transfer line such that transfer line integrity would not be challenged as detailed in Section 2.1.3. Thus, it is concluded that the transfer line is not operating at a condition where failure is imminent. The safety basis waste leak analysis (RPP-5667,

Stochastic Consequence Analysis for Waste Leaks) basis of the analysis is a flow of 155 gal/min at 1,040 ft of head (~500 lb/in^2) with a no-flow head of 1,440 ft (~ 625 lb/in^2). The design transfer conditions are less than the pressures or flows of that analyzed; therefore, this activity cannot be considered to immediately result in a waste transfer leak. Therefore, it is also concluded that this activity will not significantly affect the frequency of occurrence of the uncontrolled accident. The allocated controls, as documented in the control decision record, are only those controls relied upon in the analyzed accident. They are a combination of mitigative and preventive controls. In all cases, the analyzed accident controls were allocated as written with no recommendation or requirements for revision. Because the hazardous conditions are similar in nature to others associated with the analyzed accident, and allocated controls were selected from those used to mitigate or prevent the accident, it is determined that there would be no increase in the frequency of occurrence of the accident with controls. Consequently, it is concluded that this retrieval activity would not increase the frequency of occurrence of this analyzed accident.

Consequence: The consequence for the analyzed accident is listed as being below the offsite evaluation guidelines but exceeding those for the onsite receptor as presented in FSAR, Table 3.3.2.4.7-1. The waste transfer from SST 241-C-106 to the receiver DST will be a liquid (supernatant) with a possibility of a small amount of entrained tank solids. A 30% solids transfer is considered to be a bounding limit of transfer where, beyond this, solids settling and potential plugging would be anticipated. Consequently, a 30% solids loading would be considered a conservative number. The onsite ULD established for SST 241-C-106 in Appendix A is 2.30E+01 Sv/L for supernatant and 2.93 E+04 Sv/L for the sludge. The maximum supernatant concentration in the slurry would be for the initial sluicing effort and resulting transfer. Following transfers, SST 241-C-106 would contain much less tank liquid waste, grading down to almost none at the end of the retrieval campaign. The solids in the slurry would be conservative considering the initial slurry contained 33% sludge. Thus, the onsite ULD for the slurry is a combination of the ULDs for the supernatant and sludge is 9.68E+03 Sv/L as shown in Appendix A. The analyzed accident is based on a range of ULDs. Specifically to SST 241-C-106, the ULD for tank liquid waste from the safety basis accident analysis (RPP-5667) is 1.72 E+03 Sv/L for tank waste liquids (supernatant) and 8.68 E+03 for the tank waste solids. The ULD for the solids is an order of magnitude higher than that shown in the safety analysis; however, this value lies within the range of ULDs evaluated. According to the waste leak analysis (RPP-5667, Appendix F), the solids in SST 241-C-106 comprise < 0.2% of the total solids. The stochastic analysis-based source term was volume weighted; thus, the probability of leaking the solids from SST 241-C-106 is proportional to the waste volume fraction it represents. The inclusion of SST 241-C-106 solids accounts for < 0.2% of the source term. An increase of a factor of 10 would then provide a small incremental increase in the calculated releases of < 2%. This is an insignificant increase, especially considering the calculations are done conservatively and that the retrieval activities will send more and more dilute waste as the sluicing process and subsequent transfers proceed. Therefore, it is concluded that the waste transfer from SST 241-C-106 associated with the retrieval for closure will not significantly increase the consequence of a waste transfer leak.

Controls: The following are the safety-significant SSC identified as providing mitigative or preventive functions related to waste transfer leaks.

Pipe encasements are relied upon as mitigative measure to direct the flow of leakage from a primary transfer line to waste transfer-associated structure for detection. There are no modifications to transfer-related structures or any operational concerns that would damage or otherwise adversely affect pipe encasements. The pipe encasements work in conjunction with the transfer leak detection systems. There are no modifications to transfer-related structures or any operational concerns that would damage or otherwise affect the leak detection system. LCO 3.1.3, "Transfer Leak Detection Systems," requires transfer leak detection systems to be operable. There are no transfer-related structure modifications or operations related to this retrieval activity that would affect operability or in any way impede operability checks, maintenance, or any other activity related to the leak detectors. The supernatant transfers fall well within those analyzed for the waste transfer accident and will not affect action times or surveillance frequencies.

Overground transfer system encasements and connections are also identified as safety-significant SSC. There are no modifications to transfer-related structures or any operational concerns that would damage or otherwise adversely affect the overground transfer system. As with the pipe encasements, the overground encasements work in conjunction with the transfer leak detection systems discussed in the previous paragraph.

There is a potential backflow of waste into the raw water system because it will be used to flush the transfer lines. Thus, the pressure switch interlock or alarm system on the service water line is considered a safety-significant SSC. The pressures and flows of the water system and waste transfer pump will not damage the instrumentation. There is no retrieval activity, either during equipment installation or transfer operations that would damage this equipment. Therefore, there should be no damage or other adverse effect on this equipment. LCO 3.1.2, "Service Water Pressure Detection Systems," requires that this system be operable. Again, there are no activities associated with the equipment installation and transfer operations that would adversely affect operability. Additionally, there are no activities that would delay response actions in the event that the system is declared inoperable for any reason. Likewise, there are no activities that would restrict the ability to do functional tests or required surveillance, nor would the surveillance period need to be changed (shortened) for any reason because of possible deterioration of the system or possible higher release consequences.

In addition to the two LCOs discussed in the previous paragraphs, there are eight administrative controls associated with the waste transfer leak analyzed accident and applicable to this retrieval activity. The requirements of AC 5.12, "Transfer Controls," can be met with no restriction or modification. There are no equipment installation activities that prevent protection of the overground transfer line from vehicle impact. There is no instance where installed equipment or retrieval/transfer operations prevent isolation valves from functioning properly. Likewise, retrieval/transfer operations will not interfere with performing accurate material balance measurements during transfers. There is no installed equipment or retrieval/transfer operations that prevent ensuring that encasement seal loop drain line isolation valves (hydrostatic test lines) associated with physically connected piping provide an open drain path to the pits in accordance with AC 5.13, "Encasement Seal Loop Controls." This retrieval activity will not impede or otherwise cause problems with emergency response procedures or actions in accordance with the requirements of AC 5.14, "Emergency Preparedness." There are no activities or installed equipment that would restrict or prevent

calibration, maintenance, or use of process instrumentation, measuring, and test equipment in accordance with the requirements of AC 5.19, "Process Instrumentation and Measuring and Test Equipment." All transfer pumping equipment is designed to meet the requirements of AC 5.20, "Transfer Pump Administrative Lock Controls," and there are no transfer operation processes whereby this procedure could not be followed. Likewise, tank level measurement equipment, service water flow totalizers, other measurement equipment, and retrieval/transfer operations do not adversely affect the ability to meet the requirements of AC 5.21, "Tank Service Water Intrusion Monitoring Program." AC 5.22, "Transfer System Cover Removal Controls," is not affected in any way by equipment installation or retrieval/transfer operations. Finally, there are no retrieval/closure activities that would cause any of the programs listed under AC 5.24, "Safety Management Programs," to be adversely impacted.

4.3 EFFECT ON EQUIPMENT IMPORTANT TO SAFETY

The following question is evaluated in this section: *Do any of the newly identified hazardous conditions adversely affect equipment important to safety such that there would be the possibility of a different type of malfunction, a significant increase in the frequency of malfunction, or an increase in the consequence of a malfunction?*

The finalized hazardous conditions related to retrieval of the waste in SST 241-C-106 for closure are associated with the following equipment important to safety:

- DST and AWF Tank Ventilation Systems (SC)
- SST Ventilation Systems (SC)
- Primary Tank Leak Detection Systems (SC)
- Pipe Encasements (SS)
- OGT System (SS)
- HEPA Filter Units (SS)
- DST 241-AY-102 Annulus Ventilation System (SS)
- Temperature Monitoring Systems (SS)
- Transfer Leak Detection Systems (SS)
- Ventilation Stack CAM Interlock Systems (SS)
- Pressure Switch Interlock or Alarms (Service Water Lines) (SS)

The above safety-significant (SS) and safety-class (SC) systems listed are evaluated in the following paragraphs.

AWF Tank Ventilation Systems (SC)

Related Analyzed Accident: Flammable Gas Deflagration

Safety Function: The AWF primary tank ventilation systems prevent the accumulation of flammable gas due to steady-state releases, thereby preventing the accident by reducing the frequency of occurrence. The system must maintain the vapor space to < 0 in. water gauge relative to atmospheric pressure. Verification of operability is on a daily basis.

Creation of a Malfunction of a Different Type: The transfer of liquid waste into a DST or AWF tank is a routine activity. The flow rates of transfer of the waste from SST 241-C-106 are not beyond that which would be considered normal. The hazardous conditions identified for this activity are similar to those currently identified and evaluated in the hazard analysis database. There is no appreciable difference in the waste for this particular activity that would be of concern regarding damage or malfunction of a DST or AWF tank ventilation system beyond those currently identified, as evidenced by the hazard analysis database. Therefore, it is concluded that this activity will not create a malfunction of the DST or AWF tank ventilation systems of a different type.

Effect on Frequency of Occurrence of a Malfunction: As evaluated previously for this activity, there is no adverse effect on the analyzed accidents (consequence or frequency) associated with a malfunction of a DST or AWF tank ventilation system. Transfer of the waste from SST 241-C-106 is a normal activity and the conditions of transfer (temperature, pressure, flow rate, or chemical constituents) are what would be considered a normal transfer. There are no additional activities associated with this proposed activity that directly affects the receiver tank. Therefore, it is concluded that retrieval of the waste in SST 241-C-106 for closure will not increase the frequency of occurrence of a malfunction of the tank ventilation system in the receiver AWF DST 241-AY-102.

Effect on Consequence of a Malfunction: The DST and AWF tank ventilation systems are credited as a preventive measure for the flammable gas deflagrations—DST analyzed accident. As discussed previously, there is no increase in the consequence of this accident for this activity; therefore, there would be no increase in the consequence of a failure of the tank ventilation system in the receiver AWF DST 241-AY-102.

SST Ventilation Systems (SC)

Related Analyzed Accident: Flammable Gas Deflagration

Safety Function: The active SST ventilation systems installed for retrieval of the liquid waste in SST 241-C-106 is not required to prevent the accumulation of flammable gas due to steady-state releases, as detailed in the above discussion of the flammable gas controls for a deflagration in an SST, thereby preventing a deflagration by reducing the frequency of occurrence. The active SST ventilation systems must maintain a negative vapor space pressure relative to the atmosphere with operability verified weekly. The passive SST ventilation systems provide a HEPA-filtered flow path to allow the vapor space to be in pressure equilibrium with the atmosphere. Barometric breathing through the passive ventilation system is sufficient to maintain the tank vapor space below 25% of the LFL. The passive breather filter isolation valve is checked every 10 days to ensure the flow path remains unobstructed.

Creation of a Malfunction of a Different Type: The hazardous conditions identified for sluicing and transfer of liquid waste from SST 241-C-106 are similar to those currently identified and evaluated in the hazard analysis database. Sluicing creates moisture and aerosols that could potentially plug the HEPA filters and cause a failure from a high differential pressure, which also is identified in the hazard analysis database. The ventilation system could be damaged during removal or installation of equipment. The equipment and activities associated with the tank upgrades prior to sluicing are not considered unusual and

could not affect the ventilation system in a different way. The transfer of waste could create aerosols in the tank from a leak that would plug a HEPA filter. Again, this has been identified previously. The only addition to the tank is raw water, which will not adversely affect the ventilation system. Therefore, it is concluded that this activity will not create a malfunction of the ventilation system, active or passive, in SST 241-C-106.

Effect on Frequency of Occurrence of a Malfunction: As evaluated previously for this activity, there is no adverse effect on the analyzed accidents (consequence or frequency) associated with a malfunction of an SST ventilation system. Sluicing would create moisture and some aerosols in the vapor space that plug the HEPA filter. This has been identified in the hazard analysis database. Removal and installation of equipment in the tank prior to retrieval could damage the ventilation system; however, this is considered a normal operation and is not performed any differently. For these reasons, it is concluded that retrieval of the liquid waste from SST 241-C-106 for closure will not increase the frequency of occurrence of a malfunction of its ventilation system.

Effect on Consequence of a Malfunction: The SST tank ventilation systems are credited as a preventive measure for the flammable gas deflagrations—SST analyzed accident. As discussed previously, there is no increase in the consequence of this accident for this activity; therefore, there would be no increase in the consequence of a failure of the SST 241-C-106 ventilation system.

Primary Tank Leak Detection Systems (SC)

Related Analyzed Accident: Flammable Gas Deflagration

Safety Function: The primary tank leak detection system provides an alarm to alert operators when tank waste (from misroutes or other system) leaks into the tank annulus to prevent a flammable gas deflagration in the annulus, thereby preventing the accident by decreasing the frequency of occurrence. The system, via conductivity probes or buoyancy type instrument, must detect an accumulation of 1 in. and provide an alarm signal. The annulus ventilation system CAMs are to operate continuously when the ventilation system is operating. The operability of the liquid waste detectors is verified every 6 months.

Creation of a Malfunction of a Different Type: A transfer of SST 241-C-106 liquid waste into DST 241-AY-102, will not affect the primary tank leak detection in any way. The only possible interaction is a misroute or a leak in the primary tank. The liquid waste in SST 241-C-106 will not react or otherwise adversely affect the tank, the leak detectors, or the CAMs, such that they would malfunction. Therefore, it is concluded that retrieval of the liquid waste in SST 241-C-106 for closure will not create a malfunction of the primary tank leak detection system of a different type.

Effect on Frequency of Occurrence of a Malfunction: A transfer of SST 241-C-106 liquid waste into the receiver DST would be no different than any other transfer. Thus, the likelihood of a misroute or causing a leak of the primary tank would remain unchanged. This would be the only way that this activity could interact with the leak detection system. The waste would not affect the leak detection system conductivity probes or buoyancy type instrument any differently from any other tank waste. Therefore, it is concluded that this activity will not

increase the frequency of occurrence of a malfunction of the primary tank leak detection system.

Effect on Consequence of a Malfunction: The DST and AWF primary tank leak detection systems are credited as a preventive measure for the flammable gas deflagrations—DST analyzed accident. As discussed previously, there is no increase in the consequence of this accident for this activity; subsequently, there would be no increase in the consequence of a failure of the tank ventilation system in DST 241-AY-102.

Pipe Encasements (SS)

Related Analyzed Accident: Waste Transfer Leaks

Safety Function: The pipe encasements direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thereby decreasing the consequence of a waste leak. This confines the leak to the annulus between the encasement and primary line and channels the leak to a pit at either end of the system for leak detection. Seal loop valve positions are verified prior to waste transfers to ensure they are open.

Creation of a Malfunction of a Different Type: The hazards identified for transfer of waste from SST 241-C-106 to the DST receiver tanks are similar in nature to the transfer-related hazards associated with the waste transfer leak as listed in FSAR, Appendix C, Table C-2. Pressures and flows fall well within the waste transfer leak analysis. Consequently, it is concluded that retrieval of the liquid waste in SST 241-C-106 for closure will not create a malfunction of a different type in the pipe encasements.

Effect on Frequency of Occurrence of a Malfunction: The pressures and flows for the waste transfers are well within the operating pressures of the underground transfer lines; subsequently, there is no concern that this activity will create situations where failure of components is expected. There are no other activities that are unusual, both in the type of activity or the frequency (e.g., excavations or unusual pit entries), that could cause a malfunction of this equipment at a higher frequency than would be present for any other transfer-related operation. Therefore, it is concluded that retrieval of the liquid waste in SST 241-C-106 for closure will not increase the frequency of occurrence of a malfunction of the pipe encasements.

Effect on Consequence of a Malfunction: A failure of the pipe encasement is related to a waste transfer leak. As shown in the analysis for that particular analyzed accident, there would be no increase in the consequence. Therefore, retrieval of the liquid waste in SST 241-C-106 for closure will not increase the consequence of a malfunction of the pipe encasements.

Over-Ground Transfer System (SS)

Related Analyzed Accident: Waste Transfer Leaks

Safety Function: The over-ground transfer (OGT) encasements and connections direct the flow of leaked waste from the primary line to a waste transfer-associated structure for detection, thereby decreasing the consequence of a waste leak. This confines the leak to the

annulus between the encasement and primary line and channels the leak to a pit at either end of the system for leak detection. Seal loop valve positions are verified prior to waste transfers to ensure they are open. The OGT system vehicle impact barriers protect the piping from vehicle-related damage unless administrative vehicle access limits are imposed, thereby preventing the accident by reducing the frequency of occurrence.

Creation of a Malfunction of a Different Type: The hazards identified for transfer of liquid waste from SST 241-C-106 to the DST receiver tank are similar in nature to the transfer-related hazards associated with the waste transfer leak as listed in FSAR, Appendix C, Table C-2. Pressures and flows fall well within the waste transfer leak analysis. The HIHTL is well protected under steel plates used for radiation shielding. The aboveground structures are robust to ensure radiation shielding and, as a result, protect the line from damage. Structures are designed to protect the hose from damage due to bending, pinching, and sharp edges. Consequently, it is concluded that retrieval of the waste in SST 241-C-106 for closure will not create a malfunction of a different type in the OGT encasements and connections.

Effect on Frequency of Occurrence of a Malfunction: The pressures and flows for the waste transfers are well within the operating pressures of the OGT system; subsequently, there is no concern that this activity will create situations where failure of components is expected. There are no other activities that are unusual, both in the type of activity or the frequency, (e.g., vehicle movements, crane operations) that could cause a malfunction of this equipment at a higher frequency than would be present for any other transfer-related operation. Therefore, it is concluded that retrieval of the liquid waste in SST 241-C-106 for closure will not increase the frequency of occurrence of a malfunction of the OGT encasements and connections.

Effect on Consequence of a Malfunction: A failure of the OGT encasement or connections is related to a waste transfer leak. As shown in the analysis for that particular analyzed accident, there would be no increase in the consequence. Therefore, retrieval of the liquid waste in SST 241-C-106 for closure will not increase the consequence of a malfunction of the OGT encasement or connections.

HEPA Filter Units (SS)

Related Analyzed Accident: HEPA Filter Failure—Exposure to High Temperature or Pressure

Safety Function: The HEPA filter units provide HEPA filtration of the headspace gases before release to the environment, thereby reducing the likelihood of unfiltered releases due to partial HEPA filter release events associated with HEPA filter failure due to high temperature or pressure. They shall have a minimum filtration efficiency of 99.95% for particles as small as 0.3 μm. The HEPA filter shall resist degradation from ionizing radiation and caustic vapors, resist damage caused by moisture buildup on the filter media, and resist leakage when exposed to a differential flow stream pressure of $\leq$ 10 in. water gauge.

Creation of a Malfunction of a Different Type: A review of the hazardous conditions associated with this accident (FSAR, Appendix C, Table C-2, and contained in the hazard analysis database) and comparison of these hazardous conditions with those identified in the HAZOP shows that there are no unusual or unique conditions that would result in failure of a

HEPA filter in SST 241-C-106 or the receiver DST 241-AY-102. Sluicing of the sludge in SST 241-C-106, not specifically described in the safety basis, creates aerosols that could potentially load up a HEPA filter with a subsequent failure by a high differential pressure. This particular situation, plugged HEPA filters, has been identified and is contained in the hazard analysis database. Other means of generating aerosols (e.g., in-tank spray leaks or transfers) are not unique to the retrieval of liquid waste in SST 241-C-106 for closure. For these reasons, it is concluded that this activity will not create a malfunction of a HEPA filter unit of a different type than has already been analyzed.

Effect on Frequency of Occurrence of a Malfunction: Aerosol generation and moisture buildup causing HEPA filter failure has been identified as documented in FSAR, Appendix C, Table C-2, and the hazard analysis database. These are the two principal HEPA filter failure mechanisms identified for retrieval of the liquid waste in SST 241-C-106 for closure. This transfer activity is not significantly different from any other transfer such that in-tank spray leaks, in and of themselves, would cause an increase in the frequency of occurrence of a HEPA filter. Sluicing of the sludge in SST 241-C-106 prior to the liquid waste transfer has the potential to generate large amounts of aerosols. This has been identified and the design of the portable exhauster for this activity includes a de-entrainer to capture the moisture before it reaches the HEPA filters (RPP-13222). With a de-entrainer in the ventilation line intercepting moisture droplets, wetting of the HEPA filters is controlled such that this failure mode is prevented. The flow rate of the system is set such that the differential pressure across the HEPA filters does not reach the level where filter failure would be a consideration. Subsequently, it is concluded that there will be no increase in the frequency of occurrence of a malfunction of a HEPA filter.

Effect on Consequence of a Malfunction: The consequence of a failure of a HEPA filter was evaluated in the above paragraphs that discussed the analyzed accident, HEPA filter failure—exposure to high temperature or pressure. This analysis shows there will be no increase in the consequence of a failure.

DST 241-AY-102 Annulus Ventilation System (SS)

Related Analyzed Accident: Tank Bump

Safety Function: The annulus ventilation system in DST 241-AY-102 ensures waste is maintained below temperature that could result in an organic salt-nitrate reaction, thereby decreasing the likelihood of the organic salt-nitrate reaction accident. It also provides assurance that the tank waste temperatures are maintained below those that could result in a tank bump, thus decreasing the likelihood of the tank bump accident. The ventilation system shall provide a minimum flow rate of 125 ft^3/min.

Creation of a Malfunction of a Different Type: The transfer of liquid waste from SST 241-C-106 to DST 241-AY-102 will not affect or interact with the ventilation system. In addition, the heat load of the additional waste will not create a condition where the ventilation system could not perform its intended function of cooling the waste (RPP-13707). With no direct effect (e.g., revisions to the ventilation system), it is judged that this retrieval activity will not create a malfunction of a different type for the DST 241-AY-102 annulus ventilation system.

Effect on Frequency of Occurrence of a Malfunction: Retrieval of the liquid waste in SST 241-C-106 for closure has no direct effect on the annulus ventilation system. There is no normal interaction with the tank waste and this system other than the heat transfer to the annulus. The amount of additional heat loading from SST 241-C-106 waste is minimal and would not create a situation that would damage the annulus ventilation system. Therefore, it is concluded that this retrieval activity will not affect the frequency of occurrence of a malfunction of the DST 241-AY-102 annulus ventilation system.

Effect on Consequence of a Malfunction: A malfunction of the annulus ventilation system could result in a tank bump. This has been analyzed previously in this section with a conclusion that there would be no increase in the consequence of a tank bump accident in DST 241-AY-102.

Temperature Monitoring Systems (SS)

Related Analyzed Accident: Organic Salt-Nitrate Reaction; Tank Bump

Safety Function: The temperature monitoring system provides tank waste temperature information for operator monitoring, enabling operators to take actions necessary to prevent exceeding waste temperatures at which organic salt-nitrate reactions could proceed. This decreases the frequency of the organic salt-nitrate reaction accident. This is applicable to DST and AWF tanks with heat loading of > 21,700 watts or fuel contents of > 3.8 wt% TOC. This decreases the frequency of an organic salt-nitrate reaction. The temperature monitoring system also provides tank waste temperature information for operator monitoring, enabling operators to take actions necessary to prevent exceeding waste temperatures at which significant tank bumps or steam releases could occur, thereby decreasing the frequency of occurrence of a tank bump accident.

Creation of a Malfunction of a Different Type: The temperature monitoring systems in DSTs and AWFs are designed to resist the stresses associated with transfers into the tank, and to be operable throughout the full temperature range covered in the TSR safety limit on temperature and the LCOs associated with temperature. Temperature monitoring in SST 241-C-106 is not required as a TSR-level control; consequently, the effects on sluicing will not affect a temperature monitoring system that is important to safety. Waste transfer associated with this retrieval activity will fall within the pressures and flows currently analyzed, so this activity would not mechanically produce a new type of malfunction. Because the waste types are compatible (RPP-13707), there would be no chemical damage to temperature monitoring systems. The additional waste would not raise the temperature in the tank such that it would approach the design limit for these systems. There is no other interaction; therefore, retrieval of the liquid waste in SST 241-C-106 for closure will not create a malfunction of a different type in the temperature monitoring systems.

Effect on Frequency of Occurrence of a Malfunction: There are no direct interactions on the temperature monitoring systems with the exception of forces on the thermocouple trees caused by the waste transfer. Transfers, pressure, and flow fall within a normal transfer into a DST or AWF tank. There are no other mechanisms identified that would affect temperature monitoring equipment. For these reasons, it is determined that there will be no change to the

frequency of occurrence of a malfunction of temperature monitoring systems as a result of retrieval of the liquid waste in SST 241-C-106 for closure.

Effect on Consequence of a Malfunction: The organic salt-nitrate reaction is not applicable for enhanced sluicing and slurry transfers. The malfunction of temperature measurement equipment resulting in a tank bump would not cause an increase in consequence as discussed above.

Transfer Leak Detection Systems (SS)

Related Analyzed Accident: Waste Transfer Leaks; Flammable Gas Deflagrations

Safety Function: The safety function of the transfer leak detection system detects the waste transfer system leak in the waste transfer-associated structures and provides an alarm to alert operators to take mitigative action to shut down the transfer pump (or other motive force) and to take response actions to limit worker exposure. This limits the volume of waste leaked and the time workers are exposed, thereby decreasing the consequence of the waste transfer leak accident. The transfer leak detection system may also be connected to the MPSS that automatically shuts down the transfer pump. The transfer leak detection system also provides an alarm when waste leaks accumulate in transfer-associated structures to alert operators to take preventive actions, thus decreasing the frequency of the flammable gas deflagration accident.

Creation of a Malfunction of a Different Type: Retrieval of the liquid waste in SST 241-C-106 for closure would not normally have any interaction with transfer leak detection equipment. The tank waste is diluted with raw water and would be compatible with any leak detection equipment, insofar as it would be able to detect a leak. The waste would not react or otherwise interact with the leak detection systems such that they would be damaged. The waste temperature would not be of concern. Consequently, it is determined that this retrieval activity will not create a malfunction of a different type in the transfer leak detection system.

Effect on Frequency of Occurrence of a Malfunction: Retrieval of the liquid waste in SST 241-C-106 for closure would normally only interact with transfer leak detection equipment in the event of a leak. The tank waste is diluted with raw water and would be compatible with any leak detection equipment, insofar as it would be able to detect a leak. The waste would not react or otherwise interact with the leak detection systems such that they would be damaged. The waste temperature would not be of concern. Consequently, it is determined that this retrieval activity will not increase the frequency of occurrence of a malfunction of the leak detection system.

Effect on Consequence of a Malfunction: The leak detection system is related to both waste transfer leaks and flammable gas deflagration analyzed accidents. The consequence of a waste transfer leak is not affected by this retrieval activity as presented in the above discussion of that accident.

Ventilation Stack CAM Interlock Systems (SS)

Related Analyzed Accident: HEPA Filter Failure—Exposure to High Temperature or Pressure

Safety Function: The ventilation stack CAM interlock system shuts down the active ventilation system when radionuclide particulate activity in excess of 10,000 counts per minute is detected by the CAM. This limits radioactive material release to the atmosphere, thereby decreasing the consequences of the HEPA filter failure—exposure to high temperature or pressure accident. Upon CAM failure, the monitors shall actuate an alarm.

Creation of a Malfunction of a Different Type: The ventilation stack CAM interlock system is connected to the CAM and thus does not directly interact with the tank atmosphere. This equipment is designed to respond to a CAM when radiation levels exceed the set point. There is no portion of the waste retrieval process that would be sufficiently different from other waste retrieval or transfer operations that would be of concern for causing a malfunction of this equipment more so than any other similar tank farm activity. There are no chemical additions or reactions expected that could enter the ventilation system and react with, or otherwise damage, this equipment. Finally, there are no unusual manned activities that could cause damage to wiring, interlock relays, or other associated equipment. Therefore, it is concluded that retrieval of the liquid waste in SST 241-C-106 for closure will not cause a malfunction of a different type of the ventilation stack CAM interlock systems.

Effect on Frequency of Occurrence of a Malfunction: No activity associated with this waste retrieval process, including sluicing the sludge prior to liquid waste transfer, would create a condition that, in and of itself, would cause a malfunction of the stack CAM interlock system. Startup and shutdown of equipment (raw water sluicing, waste liquid recycling, or liquid waste transfer) should not cause extremes in ventilation pressure, flow rates, or electrical surges (spikes). There are no chemical additions or reactions expected that could enter the ventilation system and then react with, or otherwise damage, this equipment. Finally, there are no unusual manned activities that could cause damage to wiring, interlock relays, or other associated equipment. For these reasons, it is determined that retrieval of the liquid waste in SST 241-C-106 for closure will not cause an increase in the frequency of occurrence of a malfunction of the ventilation stack CAM interlock systems.

Effect on Consequence of a Malfunction: A malfunction of the service water pressure switch or interlock is directly associated with the consequence of a HEPA filter failure. The above analysis of the HEPA filter failure—exposure to high temperature or pressure analyzed accident shows that there is no increase in the consequence of this accident; therefore, there would be no increase in the consequence of a failure of the ventilation stack CAM interlock systems.

Pressure Switch Interlock or Alarms (Service Water Lines) (SS)

Related Analyzed Accident: Waste Transfer Leak

Safety Function: The pressure switch interlock or alarm (service water lines) safety function is to detect backflow of waste into the waste piping system when physically connected to a

waste transfer route. Detection of pressure in the line will either disconnect the power to the pump (interlock) or alarm to alert the operators to take action and shut down the transfer, thereby decreasing the frequency of the waste transfer leak accident if the system pressure boundary integrity is tested to full-transfer system pressure. Where boundary integrity is tested to less than full-transfer system pressure, the interlock or alarm reduces the consequence of the waste transfer leak accident by the response actions limiting the exposure to onsite and facility workers.

Creation of a Malfunction of a Different Type: The pressure sensors in the raw water flush lines would sense a backflow of SST 241-C-106 liquid waste. This equipment is designed to handle the pressure, flow, and chemistry of these liquids. There is no portion of the waste retrieval process that would be sufficiently different from other waste transfer operations which would be of concern for causing a malfunction of this equipment more so than any other waste transfer operation. Startup and shutdown of transfer equipment should not cause extremes in pressure, flow rates, or electrical surges (spikes). There are no chemical additions or reactions expected that could react with, or otherwise damage, this equipment. Finally, there are no unusual manned activities that could cause damage to wiring, interlock relays, or other associated equipment. Therefore, it is concluded that retrieval of the liquid waste in SST 241-C-106 for closure will not cause a malfunction of a different type of the service water pressure switch or interlocks.

Effect on Frequency of Occurrence of a Malfunction: The pressure switch/interlock system is designed to handle the pressure, flow, and chemistry of either raw (service) water or the SST 241-C-106 liquid waste. No activity associated with this waste retrieval process, including sluicing of the sludge in SST 241-C-106 prior to liquid transfer, would create a condition that, in and of itself, would cause a malfunction of this equipment. Startup and shutdown of transfer equipment should not cause extremes in pressure, flow rates, or electrical surges (spikes). There are no chemical additions or reactions expected that could react with, or otherwise damage, this equipment. Finally, there are no unusual manned activities that could cause damage to wiring, interlock relays, or other associated equipment. Consequently, it is determined that retrieval of the liquid waste in SST 241-C-106 for closure will not cause an increase in the frequency of occurrence of a malfunction of the service water pressure switch or interlocks.

Effect on Consequence of a Malfunction: A malfunction of the service water pressure switch or interlock is directly associated with the consequence of a waste transfer leak. The above analysis of this analyzed accident shows that there is no increase in the consequence of this accident; therefore, there would be no increase in the consequence of a failure of the service water pressure switch or interlock.

5.0 CONTROL ALLOCATION

5.1 METHODOLOGY

The control process described herein was used to identify the set of controls required to either prevent or mitigate the hazardous conditions identified in the HAZOP. Controls include safety-class and safety-significant SSC; TSRs; and DID controls. The control decision/ allocation process centers on a review by knowledgeable individuals (see Appendix B) that formally evaluate the hazardous conditions and the selection of controls. The control decision record (Appendix D) summarizes the discussions and documents the control decisions used to allocate the control for the hazardous conditions. The control decision/allocation process follows the steps outlined in FSAR, Section 3.3.1.5. This process is further described in the "Hazard and Accident Analysis Process" procedure found in the HNF-IP-0842, *RPP Administration*, Vol. 4, "Engineering," Section 6.9, "Hazard and Accident Analysis Process," Rev. 1a.

The results of the HAZOP are considered during the review cycle, making appropriate changes based on additional knowledge or upon review of similar hazardous conditions already analyzed as part of the safety basis. The hazardous conditions identified during the HAZOP meeting were evaluated by comparing the hazardous conditions to those already identified and documented in the hazard analysis database (HNF-SD-WM-TI-764). The hazardous conditions were then mapped to existing analyzed accidents as listed in FSAR, Appendix C. Where indicated during the original HAZOP sessions, additional information was gathered or developed relevant to control selection for evaluation during the control selection process. Appropriate safety basis controls are allocated as related to the analyzed accident mapped to hazardous condition, as detailed in FSAR, Chapter 3.0. Anticipated worker safety hazards (S1/F3) are not mapped to an analyzed accident. Those worker safety issues of a very serious nature (e.g., major injury, possible death, or significant worker exposure to radiological or hazardous material) were also assigned safety basis controls. Other anticipated worker safety hazards of a less serious nature were not assigned safety basis controls; however, the appropriate programmatic controls (e.g., radiation control, or industrial health and safety) were documented in the control decision record (Appendix D). Chapter 4.0 of this report evaluated the effect on the controls assigned to mitigate or prevent the analyzed accidents related to retrieval of the liquid waste in SST 241-C-106 following raw water sluicing of the sludge. With the exception of the lifting related controls for removal of long-length equipment in SST 241-C-106, specifically the heel jet pump, there was no condition identified that would invalidate or otherwise require revision or exception. Finally, the controls for each hazardous condition as related or mapped to analyzed accidents were evaluated by the reviewers and a consensus reached to ensure the controls selected from the suite of controls for a specific accident were appropriate to the specific hazardous condition.

5.2 ALLOCATED CONTROLS

The results of the control decision/allocation process are documented in the control decision record, Appendix D. Several changes were made to the initial listing of hazardous conditions from the HAZOP, as listed in Appendix E. These changes are documented in the control

decision record as a revision to the original HAZOP with discussion of the changes in the remarks for each hazardous condition.

Table 5-1 presents the final results of the hazard identification and control decision/allocation process. Definitions of the information presented in this table are found in Appendix C. By established convention, all S0-E0/E1 and S1-F0/F1/F2 hazardous conditions do not require controls and the entry in the table is left blank. Also by convention, S0/S1-E0/E1 hazardous conditions are not mapped to representative accidents. All S2/S3-E2/E3 hazardous conditions are mapped to representative accidents. The hazardous conditions are listed in ascending order of the representative accidents as numbered in FSAR, Appendix C. The hazardous conditions sorted according to representative accidents are discussed in the following paragraphs.

Low Consequence Hazardous Conditions Not Related to a Representative Accident. By established convention, all S0-E0/E1 and S1-F0/F1/F2 hazardous conditions are not related to representative accidents and do not have assigned controls. No controls are required as established by the FSAR, Table 3.3.1.5-2, Risk Matrix.

Nine hazardous conditions were identified as having only a minimal release of material or insignificant hazards associated with ionizing radiation (S0/S1). They are not assigned to a Rep Acc and have no required controls. Four of these conditions were not associated with radiation exposures or releases; all related to operational upsets, with no safety or environmental consequence. The remaining five were conditions affecting the facility worker with minimal environmental impact, having a "low" frequency of occurrence.

Low Consequence Hazardous Conditions with Higher Environmental Consequences. Seven hazardous conditions were identified having no safety consequence (S0) but having a higher environmental consequence (E2 or E3). These include damage to the tank liner with subsequent leakage of tank waste to the soil column. There are no controls assigned to these conditions. Hazardous conditions with significant environmental impact, but low safety consequence (S0/S1), are addressed by environmental controls specified in FSAR, Section 3.3.2.3.4, Table 3.3.2.3.4-1.

Anticipated Hazardous Conditions Affecting the Facility Worker (S1/F3). Seventeen "anticipated" (F3) hazardous conditions were identified that affected only the facility worker (S1). Again by established convention, S1/F3 hazardous conditions are not mapped to a representative accident and the related field in the hazard analysis database is left blank. Consideration of controls is required as established by the FSAR, Table 3.3.1.5-2, Risk Matrix. The TSR-level controls are not normally assigned to worker safety, S1 hazardous conditions, relying upon programmatic controls (e.g., radiation protection, worker health and safety) to either prevent or mitigate the hazardous condition. The exception to this is when the hazard to the facility worker is severe, such as significant exposure to ionizing radiation or a life-threatening injury, then TSR-level controls are assigned. Two worker safety-related hazardous conditions were identified where TSR-level controls were assigned. The first (ID C106PHASE-1-A-10) involves failure of a crane. Because of the potential severity of injury, AC 5.16, "Load Lifting and Dome Loading Controls (Hoisting and Rigging)," was assigned as a preventive measure. The second (ID C106PHASE-1-F-08) involves damage from very high winds or a tornado. Because of the potential massive damage, AC 5.14, "Emergency Preparedness (Response Procedures)," was assigned to mitigate the consequences. The

remaining facility worker hazardous conditions were not assigned TSR-level controls because it was determined they were adequately addressed by tank farm safety management programs.

Hazardous Conditions Mapped to Representative Accidents. All hazardous conditions related to a nuclear criticality and all others with an initial safety consequence of S2 or S3, regardless of frequency, are mapped to a representative accident. There are 69 of these higher consequence hazardous conditions related to the representative accidents. The controls allocated to the hazardous conditions were selected from those controls listed in the representative accident analysis as written with the following exceptions.

LCO 3.2.3, "SST Ventilation Systems—Passive" is applicable to 241-C-106 per recent TSR revision. There is a blanket statement in FSAR, Section 4.3.4, stating that SST passive and active ventilation systems are safety-class SSC. The safety classification of the active ventilation system for enhanced sluicing would be considered general service considering the low gas generation rate coupled with the dual (passive and active) ventilation system; however, the passive ventilation system would be considered a safety-class SSC. Thus, for flammable gas purposes, LCO 3.2.2 would not be applicable. LCO 3.2.3, "SST Ventilation Systems—Passive," is applicable. The low flammable gas generation rates ensure that surveillance periods for flammable gas concentration and completion times for LCO 3.2.3 becomes very conservative and thus remain valid.

Furthermore, the following additional controls are required that are related to removal of long-length equipment from SST 241-C-106:

- ID No. C106PHASE-1-A-12: This hazardous condition is related to a leak of waste trapped in the heel jet pump in SST 241-C-106. In addition to the appropriate controls from the associated representative accident, additional controls specific to this long-length equipment removal activity are required. These controls are specified in the SER (Schepens 2002). The additional control is:

  The receiver bag to be used for the heel pump will be designed and constructed of material of sufficient strength to contain the MAR resulting from postulated failures of equipment (i.e., the heel pump flexible hose and 590 lb of waste). The design and material of the receiver bag as described by H-2-79350, "TWRS 70' Flexible Receiver Bag Assy for 42" Riser," will be verified by mock-up testing. To ensure receiver bags have not degraded during storage, the receiver bag used shall have been in storage < 7 yr and protected from ultraviolet light.

- ID No. C106PHASE-1-A-13: This hazardous condition is load drop related, specifically dropping the heel jet pump when hoisting it out of the tank and then inserting it into the vertically oriented storage container. The SER requires the following controls:

  AC 5.16.2a.2. is applicable, which states, "For mechanically lifted loads within 20 ft of SSTs (100 Series), DSTs, and AWF tanks, the lower equipment boundary of the lifted item (e.g., bottom of the cover block, thermocouple tree) shall be < 20 ft above surface grade, or pit floor above a WASTE storage Tank (covered or uncovered)."

Critical lift procedures shall be used to remove the heel pump and transfer pump from SST 241-C-106. The critical lift procedure shall not allow lifting in wind speeds that exceed 15 mi/h.

- ID No. C106PHASE-1-A-14: This hazardous condition is related to wind damage to the flexible receiver when removing the heel jet pump. The SER requires the following controls:

  The receiver bag to be used for the heel pump will be designed and constructed of material of sufficient strength to contain the MAR resulting from postulated failures of equipment (i.e., the heel pump flexible hose and 590 lb of waste). The design and material of the receiver bag as described by H-2-79350, "TWRS 70' Flexible Receiver Bag Assy for 42" Riser," will be verified by mock-up testing. To ensure receiver bags have not degraded during storage, the receiver bag used shall have been in storage < 7 yr and protected from ultraviolet light.

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-A-01	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from unfiltered release paths and damaged ventilation system to the atmosphere due to a flammable gas deflagration	Removal of in-tank equipment (e.g., heel jet pump) causes spark and ignites flammable gas	SS: Vent Syss	LCO: Vent Syss-Passive AC: Flamm Cntrls AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F2	E2
C106PHASE-1-A-02	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from unfiltered release paths and damaged ventilation system to the atmosphere due to a flammable gas deflagration	Installation of new equipment (e.g., supernatant pump) causes spark and ignites flammable gas	SS: Vent Sys	LCO: Vent Sys AC: Flammability Cntrls AC: Ign Cntrls (Flamm Gas) AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None Required	AC: Emergency Prep AC: HEPA Filter Cntls	Controls based on SB, FSAR Appendix K.	S2	F2	E2
C106PHASE-1-A-03	06X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from damaged HEPA filter to atmosphere due to high temperature	Vehicle strikes object rupturing the fuel tank causing fire near the 241-C-106 passive ventilation system damaging the HEPA filter	None	None	None	AC: HEPA Filter Cntrls AC: Process Instrumentation/Measure/Test Equip	Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.	S2	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-A-04	06X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from damaged HEPA filter to atmosphere due to high temperature	Vehicle strikes object rupturing the fuel tank causing fire near the 241-C-106 active ventilation system damaging the HEPA filter	None	None	SS: Vent Stack CAM Intrlk Syss	LCO: Vent CAM Intrlk Syss AC: HEPA Filter Cntrls AC: Process Instrument/Measure/Test Equip	Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.	S2	F3	E2
C106PHASE-1-A-05	06X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from damaged HEPA filter to atmosphere due to high temperature	Vehicle strikes object rupturing the fuel tank causing fire near the receiver DST ventilation system damaging the HEPA filter	None	None	None	LCO: Vent Stack CAM Intrlk Syss AC: HEPA Filter Cntrls AC: Process Instrument/Measure/Test Equip	Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.	S2	F3	E2
C106PHASE-1-A-06	07X	Contamination from pit.	Release of radioactive or hazardous material from a pit to the atmosphere due to a fire	Vehicle strikes pit rupturing the fuel tank which drains into a pit and ignites	None	AC: Ign Cntrls (Vehicle Cntrls)	None	AC: Emergency Prep	Controls based on analyzed accident, Fire in Contaminated Area.	S2	F3	E2
C106PHASE-1-A-07	---	Contamination in pit.	Release of radioactive or hazardous materials from pit to the atmosphere due to high winds	High winds/dust devil during plug removal from pit cover or pit cover removal or equipment installation or removals	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E1
C106PHASE-1-A-08	---	SST headspace aerosols.	Release of radioactive or hazardous material from unfiltered release paths through damaged tank dome due to excessive loads	Worker error positions crane over 241-C-106 when lifting cover blocks or installing other on tank equipment (e.g., water skid) causing damage to the tank dome	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E1

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-A-09	---	SST headspace aerosols.	Release of radioactive or hazardous material from unfiltered release paths through damaged tank dome due to excessive loads	Worker error causes too much lifting force when removing stuck heel jet pump in 241-C-106 heel pit with resultant riser damage	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E1
C106PHASE-1-A-10	---	NA	Serious injury or fatality due to overloaded crane and boom failure	Worker error cause too much lifting force when removing equipment causing crane or rigging failure	None	AC: Load Lifting and Dome Loading Cntrls	None	None	AC: 5.16 Load Lifting and Dome Loading Controls (Hoisting and Rigging) invoked because of the high consequence to the facility worker.	S1	F3	E0
C106PHASE-1-A-11	---	Headspace aerosols.	Release of radioactive or hazardous material to the atmosphere due to an unfiltered release	Improperly assembled or damaged ventilation system causes unfiltered release path around HEPA filter	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E1
C106PHASE-1-A-12	33CX	Tank waste	Release of radioactive or hazardous material from the 241-C-106 heel jet pump to the ground due to a leak in the flexible receiver, or other containment device	Waste trapped in heel jet pump is released from the flexible receiver when it is lifted from the tank causing a waste leak to the ground surface	None	None	None	AC: Emergency Prep AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident. Waste Transfer Leak plus additional controls related to the specific activity of removal of long-length equipment from SST 241-C-106 as documented in the SER, (Schepens 2002).	S2	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-A-13	12BX	Tank waste	Release of radioactive or hazardous material from ruptured 241-C-106 dome to the atmosphere due to load drop	Rigging failure caused load drop when removing the 241-C-106 heel jet which falls from height sufficient to clear vertically oriented disposal container	None	AC: Load Lifting and Dome Loading Cntrls	None	None	Controls based on SER, (Schepens 2002).	S2	F2	E2
C106PHASE-1-A-14	31X	Tank waste	Release of radioactive or hazardous material from long-length equipment flexible receiver due to high wind	High wind causes damage to flexible receiver on SST 241-C-106 heel jet pump during removal causing release of trapped tank waste	None	None	None	None	Controls based on SER, (Schepens 2002).	S2	F3	E2
C106PHASE-1-B-01	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere through breached filters due to ignition of flammable gas	Gas release event (GRE) induced by large water intrusion (misroute) into tank with ignition of flammable gas and resulting filter breach	SS: Vent Syss	LCO: SST Vent Syss - Passive AC: Flammability Cntrls AC: Ign Cntrls (Flamm Gas) AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F2	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-B-02	---	SST waste	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere from unfiltered pathways due to tank failure due to excessive loads	Leak of service water saturates soil above tank 241-C-106 causing tank overload and dome cracking	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S1	F0	E1
C106PHASE-1-B-03	---	Tank waste	Release of liquid waste from tank 241-C-106 to soil subsurface due to service water leak in sluice pit	Large water intrusion resulting in high liquid level in tank and primary liner rupture	None Required	None Required	None Required	None Required	No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (S0/S1) are addressed by Environmental Controls specified in Tank Farms FSAR, Section 3.3.2.3.4, "Environmental Protection" (Table 3.3.2.3.4-1).	S0	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-B-04	---	NA	Release of radioactive liquid from tank 241-C-106 to tank 241-C-105 due to large water intrusion	Intrusion of water into tank 241-C-105 from tank 241-C-106 due to cascade effect	None Required	None Required	None Required	None Required	No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (S0/S1) are addressed by Environmental Controls specified in Tank Farms FSAR, Section 3.3.2.3.4, "Environmental Protection" (Table 3.3.2.3.4-1).	S0	F1	E0
C106PHASE-1-B-05	33DX	Tank waste	Release of radioactive or hazardous materials from service water system to atmosphere due to spray leak from starting supernatant transfer pump in tank 241-C-106 during the flush of slurry transfer line	Supernatant transfer pump in tank 241-C-106 is started during the flush of transfer line and flush line is filled and pressurized resulting in flushline leak or backflow into service water system	SS: Pressure Switch Intrlk or Alarm Syss (Service Water Lines)	LCO: Service Water Pressure Detect Syss AC: Trans Pump Admin Lock Cntrls	SS: Pressure Switch Intrlk or Alarm Syss (Service Water Lines)	LCO: Service Water Pressure Detect Sys AC: Emergency Prep AC: Process Instrument/Measure/Test Equip[	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2
C106PHASE-1-B-06	33DX	Tank waste	Release of radioactive or hazardous materials from service water system to atmosphere due to spray leak from a backflow of tank waste into the service water system	Valve alignment is incorrect or leaking valves cause waste from the supernatant transfer pump in tank 241-C-106 to backflows into service water system resulting in waste leak	SS: Pressure Switch Intrlk or Alarm Syss (Service Water Lines)	LCO: Service Water Pressure Detect Syss AC: Trans Pump Admin Lock Cntrls	SS: Pressure Switch Intrlk or Alarm Syss (Service Water Lines)	LCO: Service Water Pressure Detect Syss AC: Emergency Prep AC: Process Instrument/Measure/Test Equip	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-B-07	33CX	Tank waste	Release of radioactive liquid from tank 241-C-106 to the soil surface due to tank overflow	Large water intrusion (Service water, surface flood, cascade) or excessive transfer causing overflow of tank	None	AC: Tank Service Water Intrusion Mon Program	None	AC: Emergency Prep AC: Process Instrument/Measure/Test Equip	Controls based on analyzed accident, Waste Transfer Leak	S2	F1	E2
C106PHASE-1-B-08	07X	Contamination from pit.	Release of radioactive or hazardous waste from the sluice or pump pit on 241-C-106 to the atmosphere due to hydraulic fluid fire in the pit	Rupture of a hydraulic line to the sluicing articulation actuators leaks into the 241-C-106 sluice or pump pit and is ignited releasing contamination in the pit	None	None	None	AC: Emergency Prep	Controls based on analyzed accident, Fire in Contaminated Area.	S2	F2	E2
C106PHASE-1-B-09	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to flammable gas deflagration	A hot spot or spark from the supernatant transfer pump ignites flammable gas released during sluicing causing failure of the ventilation system and continued unfiltered release	SS: Vent Syss	LCO: Vent Syss AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F2	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-C-01	---	SST headspace aerosols	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to tank dome breach from impact	During sluicing operations, sluicer moves debris in waste impacting drop leg or in tank equipment, which breaches dome causing unfiltered release (assumes ventilation system failure)	None Required	None Required	None Required	None Required	No controls required for S1/F1 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S1	F1	E1
C106PHASE-1-C-02	---	Tank waste	Release of radioactive or hazardous material from 241-C-106 to the soil column due to tank liner breach	Mechanical failure causes sluicer to fall puncturing tank bottom	None Required	None Required	None Required	None Required	No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but how safety consequence (S0/S1) are addressed by Environmental Controls specified in Tank Farms FSAR, Section 3.3.2.3.4, "Environmental Protection" (Table 3.3.2.3.4-1).	S0	F1	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-C-03	---	Tank waste	Release of radioactive or hazardous material from 241-C-106 to the soil column due to tank liner breach	Sluice jet impinges on weak section of tank wall causing minor leak of water or tank waste behind liner and subsequent leak to soil column	None Required	None Required	None Required	None Required	No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (S0/S1) are addressed by Environmental Controls specified in Tank Farms FSAR, Section 3.3.2.3.4, "Environmental Protection" (Table 3.3.2.3.4-1).	S0	F2	E2
C106PHASE-1-C-04	---	Tank waste	Release of radioactive or hazardous material from 241-C-106 to the soil column due to tank liner breach	Sluice jet impinges on flashing causing minor leak of water or tank waste behind liner and subsequent leak to soil column	None Required	None Required	None Required	None Required	No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (S0/S1) are addressed by Environmental Controls specified in Tank Farms FSAR, Section 3.3.2.3.4, "Environmental Protection" (Table 3.3.2.3.4-1).	S0	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-C-05	---	Tank waste	Transfer of contaminated sluice water to 241-C-105 due to backflow of sluice water/slurry through cascade line	Sluice jet impinges on cascade line causing water to backflow to 241-C-105	None Required	None Required	None Required	None Required	No controls required for S0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S0	F3	E0
C106PHASE-1-C-06	01X	Radioactive fission gasses	Release of ionizing radiation and radioactive gas from tank 241-C-106 to the atmosphere due to criticality in the tank	Excessive solids in slurry flow towards supernatant transfer pump	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2
C106PHASE-1-C-07	01X	Radioactive fission gasses	Release of ionizing radiation and radioactive gas from tank 241-C-106 to the atmosphere due to criticality in the tank	Material reaches critical mass/formation during sluicing activities	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-C-08	05X	Tank headspace aerosols and HEPA filter loading	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to flammable gas deflagration	The sluicer impinging into the solids releasing a region of retained flammable gas which is then ignited	SS: Vent Syss	LCO: Vent Syss-Passive AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F2	E2
C106PHASE-1-C-09	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	Sluicing nozzle strikes object when being indexed causing spark and ignition of flammable gas with damage to the ventilation system	SS: Vent Syss	LCO: Vent Syss-Passive AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F2	E2
C106PHASE-1-C-10	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	Sluice jet moves debris causing spark and flammable gas ignition with damage to the ventilation system	SS: Vent Syss	LCO: SST Vent Syss-Passive AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F2	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-C-11	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	Hydraulic reaction force of jet bends sluicing mechanism against riser causing friction when indexing and ignition of flammable gas with damage to the ventilation system	SS: Vent Syss	LCO: SST Vent Syss-Passive AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F2	E2
C106PHASE-1-C-12	13X	Tank waste	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to vacuum induced tank damage	Water spray through sluice nozzle cools tank headspace resulting in excessive tank vacuum damaging tank	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S2	F1	E2
C106PHASE-1-C-13	13X	Tank waste	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to vacuum induced tank damage	Water spray through anti-siphon holes causes rapid cooling of the headspace resulting in excessive tank vacuum and tank breach	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S2	F1	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-C-14	---	HEPA loading and tank headspace aerosols	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to a steam bump	Sluicing reduces the confinement over a hot spot in the sludge where the temperature has reached saturation causing a localized steam eruption	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S1	F0	E1
C106PHASE-1-C-15	18AX	Tank waste	Release of liquid waste from tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	High pressure sluice induces movement of debris present in waste which impact and breaches the tank liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2
C106PHASE-1-C-16	18BX	HEPA filter loading and tank headspace aerosols	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere through failed filters due to condensation of vapor in head space	Condensation of vapor in head space of tank 241-C-106 resulting from the breaking off sluicer head causes large pressure drop in the dome space (sluicer failure, water hammer, thermal shock, corrosion or fatigue) causing reverse airflow and HEPA failure	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-C-17	33AX	Tank waste	Release of radioactive or hazardous materials from tank 241-C-106 sluice pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	None	None	SS: Trans Leak Detect Syss	LCO: Trans Leak Detect Syss AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Trans Cover Removal Cntrls AC: Safety Management Programs (Radiation Programs)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2
C106PHASE-1-C-18	33AX	Tank waste	Release of radioactive or hazardous materials from tank 241-C-106 sluice pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	None	None	SS: Trans Leak Detect Syss	LCO: Trans Leak Detect Syss AC: Waste Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Trans Cover Removal Cntrls AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2
C106PHASE-1-C-19	33CX	Tank waste	Release of radioactive or hazardous material from 241-C-106 from pits and risers to the ground surface due to overfilling the tank with sluice water	Sluicing with service water for long period of time or during back flush with no or insufficient pumping causes tank overflow	None	None	None	AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak	S2	F2	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-C-20	---	Tank headspace aerosols	Release of radioactive or hazardous material from 241-C-106 to the atmosphere from unfiltered release paths due to a tank pressurization	Sluice water evaporates in relatively dry headspace causing a momentary positive spike in headspace pressure releasing headspace contaminates through unfiltered leak paths	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E1
C106PHASE-1-D-01	---	NA	Worker exposed to ionizing radiation when replacing a damaged transfer pump	Debris (e.g., tape) damages transfer pump which must be replaced causing unplanned dose to workers	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E0
C106PHASE-1-D-02	---	NA	Worker exposed to ionizing radiation when replacing a damaged transfer pump	Electric motor hooked up backwards driving pump in reverse damages pump, which must be replaced causing unplanned dose to workers	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E0

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-D-03	01X	Radioactive fission gasses	Release of ionizing radiation and radioactive gas from tank 241-C-106 to the atmosphere due to criticality in the tank pump vortices	Accumulation of material in the pump vortices until critical mass condition are met	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2
C106PHASE-1-D-04	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to flammable gas deflagration	A hot spot or spark from slurry pump ignites flammable gas released during sluicing causing failure of the ventilation system and continued unfiltered release	SS: Vent Syss	LCO: SST Vent Syss-Passive AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F2	E2
C106PHASE-1-D-05	06X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to HEPA filter failure caused by high pressure	A leak in the supernatant transfer pump caused by a failed component or mis-assembly causes excessive aerosols which plug the HEPA causing failure by high differential pressure	None	None	SS: Vent Stack CAM Intrlk Syss	LCO: Vent Stack CAM Intrlk Syss AC: HEPA Filter Cntrls AC: Process Instrument/Measure/Test Equip	Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.	S2	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-D-06	07X	Contamination from pit.	Release of radioactive or hazardous waste from the sluice pit on 241-C-106 to the atmosphere due to hydraulic fluid fire in the pit	Rupture of a hydraulic line to the sluice nozzle indexer leaks into the 241-C-106 sluice pit and is ignited releasing contamination in the pit	None	None	None	AC: Emergency Prep	Controls based on analyzed accident, Fire in Contaminated Area.	S2	F2	E2
C106PHASE-1-D-07	33CX	Tank waste	Release of radioactive liquid from the receiver tank to soil surface due to over filling	Continued sluicing and pumping from tank 241-C-106 resulting in over flow of receiver tank and aboveground leak of tank waste	None	None	None	AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2
C106PHASE-1-D-08	33CX	Tank waste	Release of radioactive or hazardous materials from tank 241-C-106 pump pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	None	None	SS: Trans Leak Detect Syss	LCO: Trans Leak Detect Syss AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Trans Cover Removal Cntrls AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-D-09	33AX	Tank waste	Release of radioactive or hazardous materials from tank 241-C-106 pump pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	None	None	SS: Trans Leak Detect Syss	LCO: Trans Leak Detect Syss AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Trans Cover Removal Cntrls AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2
C106PHASE-1-D-10	33DX	Tank waste	Release of radioactive or hazardous material from the service water lines to the surface due to a backflow of waste	Leaking valves or incorrect valve alignment causes backflow of waste into service water line during transfer pump operation with leak through unmonitored service water system	SS: Pressure Switch Intrlk or Alarm Syss (Service Water Lines)	LCO: Service Water Pressure Detect Syss	SS: Pressure Switch Intrlk or Alarm Syss (Service Water Lines)	LCO: Service Water Pressure Detect Syss AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2
C106PHASE-1-D-11	---	SST waste	Release of radioactive or hazardous materials from tank 241-C-106 pump pit to atmosphere due to waste leak through the electrical connections into an electrical junction box	Electrical connector seal fault or improper assembly causes a flow of waste through the electrical cable up to the nearest junction box	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E1

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-E-01	---	NA	Personnel exposure to ionizing radiation due to excavation or construction activities uncovering shielding on hose-in-hose transfer lines	Error causes removal of shielding above hose-in-hose transfer line resulting in worker exposure to ionizing radiation	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E0
C106PHASE-1-E-02	---	Tank waste	Release of radioactive or hazardous material from a ruptured transfer hose to the atmosphere due to high compressed air pressure	Compressed air blowdown ruptures transfer line with release to atmosphere	None	None	None	None	No controls required for S1/F2 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S1	F2	E1
C106PHASE-1-E-03	---	NA	Worker exposure to ionizing radiation due to back flow of waste into compressed air system	Radioactive liquid gravity flows into compressed air system during line blowdown activities	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E0
C106PHASE-1-E-04	---	NA	Worker exposure to ionizing radiation due to unplugging transfer line	Excess solids causes line plug, worker exposure clearing plug	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E0

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-E-05	05X	Tank headspace aerosols and HEPA filter loading	Small release of radioactive or hazardous materials from the transfer line to the atmosphere due to flammable gas deflagration in line, transfer started	Buildup of solids and flammable gas in transfer line with ignition resulting in breach of transfer line; pumping is started without knowledge of breach	None	LCO: Trans Leak Detect Syss AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip AC: Trans Pump Admin Lock Cntrls	SS: Pipe Encas	AC: Emergency Prep	Controls based on SB, FSAR Appendix K.	S2	F2	E2
C106PHASE-1-E-06	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous materials to the atmosphere due to flammable gas deflagration in the waste transfer line	Plugging of transfer line occurs, flammable gas builds up and is ignited resulting in a breach of transfer line; pumping is started (collection in pit)	None	LCO: Trans Leak Detect Syss AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip AC: Trans Pump Admin Lock Cntrls	SS: Pipe Encas SS: OCT Encas and Connect SS: Trans Leak Detect Syss	AC: Emergency Prep	Controls based on SB, FSAR Appendix K.	S2	F2	E2
C106PHASE-1-E-07	06X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from the slurry receiver tank ventilation system to the atmosphere due to HEPA filter failure due to high pressure	Compressed air used to blow down transfer line exceeds the HEPA filter capacity in the receiver tank causing filter failure and release of contaminants	None	None	SS: Vent Stack CAM Intrlk Syss	LCO: Vent Stack CAM Intrlk Syss AC: HEPA Filter Cntrls AC: Process Instrument/Measure/Test Equip	Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.	S2	F1	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-E-08	---	NA	Personnel exposure to ionizing radiation due to high winds	High winds uncover overground transfer lines	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E0
C106PHASE-1-E-09	10X	Tank waste	Release of radioactive or hazardous material to the ground surface or atmosphere from a damaged overground transfer line due to wind blown missile	Missile caused by high wind or tornado penetrates overground transfer line causing surface or spray leak	None	None	None	AC: Waste Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2
C106PHASE-1-E-10	33CX	Tank waste	Release of radioactive or hazardous waste due to seismic induced damaged to a transfer line	Seismic event damages overground transfer line by ground motion resulting in spray release	None	None	None	AC: Emergency Prep	Controls based on analyzed accident, Waste Transfer Leak.	S2	F1	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-E-11	---	Tank waste	Release of radioactive or hazardous waste due to seismic induced damaged to a transfer line	Seismic event damages transfer line by ground motion resulting subsurface leak remaining subsurface	None Required	None Required	None Required	None Required	No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (S0/S1) are addressed by Environmental Controls specified in Tank Farms FSAR, Section 3.3.2.3.4, Environmental Protection (Table 3.3.2.3.4-1).	S0	F2	E2
C106PHASE-1-E-12	33AX	Tank waste	Release of radioactive or hazardous materials or hazardous waste from transfer line in tank 241-C-106 pit to atmosphere due to leak in line flush connection	Blank flange or hose connection left off flushing connection in pit after flushing and transfer initiated.	None	None	SS: Trans Leak Detect Syss	LCO: Trans Leak Detect Syss AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Trans Cover Removal Cntrls AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-E-13	33AX	Tank waste	Release of radioactive or hazardous materials or hazardous waste from line in pit to the surface due to leak caused by mis-positioned valve, cover plug in place	Air blow down valves left in flush configuration after flushing, cover plug remains in place on initiation of sluicing process, high capacity drain cover left on and pit overflows.	None	None	SS: Trans Leak Detect Syss	LCO: Trans Leak Detect Syss AC: Waste Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Trans Cover Removal Cntrls AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2
C106PHASE-1-E-14	33CX	Tank waste	Release of radioactive or hazardous material from overground transfer hose to the ground due to a leaking connection	High temperature water flush degrades seal at hose joint connection causing leak to ground surface	None	None	SS: OGT Encas and Connect	AC: Trans Cntrls AC: Encas Seal Loop Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Trans Cover Removal Cntrls AC: Safety Management Program (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2
C106PHASE-1-E-15	33CX	Tank waste	Release of radioactive or hazardous materials to the surface due to ruptured transfer line	Overground transfer line break due to light aircraft strike	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-E-16	33AX	Tank waste	Release of radioactive liquid from overflow of pit on slurry receiver DST to soil surface due to transfer line leak	Jumper break or improper installation in pit with the high capacity drain cover on resulting in overflow of pit	None	None	SS: Trans Leak Detect Syss	LCO: Trans Leak Detect Syss AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Trans Cover Removal Cntrls AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak	S2	F3	E2
C106PHASE-1-E-17	33AX	Tank waste	Release of radioactive liquid from overflow of pit on slurry receiver DST to soil surface due to transfer line leak	Jumper break or improper installation in pit with the high capacity drain cover open and pit cover off	None	None	SS: Trans Leak Detect Syss	LCO: Trans Leak Detect Syss AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Trans Cover Removal Cntrls AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-E-18	33AX	Tank waste	Release of radioactive or hazardous materials from pit to atmosphere due to spray leak from jumper	Seismic event damages jumper and breaches cover block by ground motion resulting in spray release	None	None	SS: Trans Leak Detect Syss	LCO: Trans Leak Detect Syss AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Trans Cover Removal Controls AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F1	E2
C106PHASE-1-F-01	---	NA	Worker exposure to ionizing radiation when changing HEPA filters in 241-C-104 and 241-C-105	Active ventilation system in 241-C-106 draws additional air through the cascade lines to 241-C-104 and 241-C-105 HEPAs causing additional filter changes and unplanned exposure	None Required	None Required	None Required	None Required	No controls required for S1/F2 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S1	F2	E0
C106PHASE-1-F-02	06X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere through failed filters due to moisture buildup	Moisture buildup on filters causes excessive back pressure and failure	None	None	SS: Vent Stack CAM Intrlk Syss	LCO: Vent Stack CAM Intrlk Syss AC: HEPA Filter Cntrls AC: Process Instrument/Measure/Test Equip	Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.	S2	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-F-03	06X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to HEPA filter failure	Sluicer breaks resulting in excessive aerosol generation in head space and release through failed HEPAs caused by HEPA plugging and high differential pressure	None	None	SS: Vent Stack CAM Intrlk Syss	LCO: Vent Stack CAM Intrlk Syss AC: HEPA Filter Cntrls AC: Process Instrument/Measure/Test Equip	Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.	S2	F3	E2
C106PHASE-1-F-04	---	Tank waste	Release of radioactive or hazardous materials from tank 241-C-106 to soil column due to vacuum induced tank damage	Ventilation system fan on with tank level too low and or inlet damper closed results in vacuum uplift of tank bottom and leak to soil column	None Required	None Required	None Required	None Required	See Environmental Controls in Tank Farms FSAR Chapter 3, paragraph 3.3.2.3.4, Environmental Compliance Program (Table 3.3.2.3.4-1).	S0	F3	E3
C106PHASE-1-F-05	---	Tank waste	Release of radioactive or hazardous materials from tanks connected 241-C-106 via cascade lines to the soil column due to vacuum induced tank damage	Ventilation system fan on with tank level too low and/or inlet damper closed results in vacuum uplift of tank bottom of interconnected tanks and leak to soil column	None Required	None Required	None Required	None Required	No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (S0/S1) are addressed by Environmental Controls specified in Tank Farms FSAR, Section 3.3.2.3.4, Environmental Protection (Table 3.3.2.3.4-1).	S0	F1	E3

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-F-06	13X	Tank waste and headspace aerosols	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to vacuum induced tank damage	Fan controller failure resulting in excessive vacuum in tank, loop seal actuation, and tank damage (dome damage)	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2
C106PHASE-1-F-07	18BX	Tank waste	Release of radioactive or hazardous materials to the atmosphere due to seismically-induced structural failure of the ventilation system	Seismic event causes failure of ventilation system	None Required	None Required	None Required	AC: Emergency Prep	Controls based on analyzed accident, Natural Phenomena, Seismic.	S2	F1	E2
C106PHASE-1-F-08	---	Tank headspace aerosols	Release of radioactive or hazardous materials from ventilation ducting due to high winds or tornado	High winds or tornado resulting in failed ventilation ducting and unfiltered release	None	None	None	AC: Emergency Prep	Controls based on analyzed accident, Natural Phenomena-High Wind.	S1	F3	E1
C106PHASE-1-F-09	---	Tank headspace aerosols	Release of radioactive or hazardous materials from tank 241-C-106 ventilation system to atmosphere due to ventilation system leak	Ducting corrosion or seal deterioration undetermined during sluicing	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E1

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-F-10	---	Tank headspace aerosols	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to excessive vacuum	Excessive vacuum caused by human error (closing off inlet damper) in tank from ventilation system resulting in loop seal failure and unfiltered release	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).	S1	F3	E1
C106PHASE-1-G-01	06X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous materials from receiver DST to atmosphere due to unfiltered release through failed HEPA filter	Excessive transfer flow resulting in increased aerosol generation, and which loads HEPA filters causing high differential pressure and filter failure	None	None	SS: Vent Stack CAM Intrlk Syss	LCO: Vent Stack CAM Intrlk Syss AC: HEPA Filter Cntrls AC: Process Instrument/Measure/Test Equip	Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.	S2	F2	E2
C106PHASE-1-G-02	06X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous materials from receiver DST to atmosphere due to unfiltered release through failed HEPA filter	Distributor breaks off resulting in excessive aerosol generation in head space causing high differential pressure and failure of the HEPA	None	None	SS: Vent Stack CAM Intrlk Syss	LCO: Vent Stack CAM Intrlk Syss AC: HEPA Filter Cntrls AC: Process Instrument/Measure/Test Equip	Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.	S2	F2	E2
C106PHASE-1-G-03	06X	HEPA filter loading and headspace aerosols.	Release of radioactive or hazardous materials from tank 241-AY-102 to atmosphere due to unfiltered release through failed HEPA filters	Heat loading from new waste cause loading of HEPA filters, which fail by high differential pressure with aerosol release	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-G-04	18AX	HEPA filter loading and tank headspace aerosols	Release of radioactive or hazardous materials from tank 241-AY-102 through failed filters due to tank bump	Cold water spray into tank (possible result of waste transfers) chills head space causing tank vacuum inducing resulting tank bump	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2
C106PHASE-1-G-05	33AX	Tank waste	Release of radioactive or hazardous materials from 241-C-106 to the surface through pits and risers due to backflow of waste from receiver tank	Siphon of waste from receiver tank to 241-C-106 overfills tank with leak to ground	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2
C106PHASE-1-H-01	01X	HEPA filter loading and fission gasses	Release of radioactive or hazardous material to atmosphere from 241-C-106 due to unplanned nuclear criticality	Sluicing selectively removes neutron poisons resulting in criticality, steam generation and ventilation system failure	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-H-02	05X	Tank headspace aerosols and HEPA filter loading	Release of radioactive or hazardous materials from tank 241-C-106 due to flammable gas deflagration in dome space	High waste temperature during transfer causing a steam bump, which induces a flammable gas release/ignition	SS: Vent Syss	LCO: SST Vent Syss-Passive AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F1	E2
C106PHASE-1-H-03	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to flammable gas deflagration	Temperature out of specification causing a steam bump when level is lowered resulting in release/ignition of a flammable gas	SS: Vent Syss	LCO: SST Vent Syss-Passive AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F1	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-H-04	05X	Tank headspace aerosols and HEPA filter loading	Release of radioactive or hazardous materials from tank 241-C-106 pit to the atmosphere due to spray leak from flammable gas deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in damage to transfer lines and spray release	None	LCO: Trans Leak Detect Syss AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip AC: Trans Pump Admin Lock Cntrl	SS: Trans Leak Detect Syss	AC: Emergency Prep	Controls based on SB, FSAR Appendix K.	S2	F2	E2
C106PHASE-1-H-05	09X	Tank headspace aerosols	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to organic waste fire	Formation of organic layer in tank during sluicing and subsequent ignition of organics	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S3	F0	E3
C106PHASE-1-H-06	09X	Tank headspace aerosols	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to organic waste fire	Loss of ventilation for many months, dry out of waste, and subsequent ignition of organics	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S3	F0	E3

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-H-07	---	Ammonia	Release of ammonia gas from tank to atmosphere due to burp, which exposes facility personnel to hazardous gases	Sluicing causes release of ammonia	None	None	None	None	No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Industrial Health and Safety).	S1	F3	E1
C106PHASE-1-H-08	---	Tank waste	Release of radioactive liquid waste from tank 241-C-106 to soil subsurface due to large water intrusion	Large water intrusion resulting in high hydrostatic pressure and tank breach (Service water, surface flood, excessive transfer, or cascade)	None	None	None	None	No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (S0/S1) are addressed by Environmental Controls specified in Tank Farms FSAR, Section 3.3.2.3.4, Environmental Protection (Table 3.3.2.3.4-1).	S0	F3	E2
C106PHASE-1-I-01	03X	HEPA filter loading and tank headspace loading	Release of radioactive or hazardous material from damaged 241-AY-102 ventilation system due to mixing of incompatible material	Transferred waste reacts with waste in tank causing steam or gas generation, which pressurizes the tank causing failure of the HEPA filters	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-I-02	04X	Tank headspace aerosols and HEPA filter loading	Large release of radioactive or hazardous materials from slurry receiver DST to the atmosphere due to flammable gas deflagration	Influx of cold water spray into tank causing excessive vacuum with a large flammable gas release as a result of waste transfer; gas is ignited	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S3	F0	E3
C106PHASE-1-I-03	04X	Tank headspace aerosols and HEPA filter loading	Release of radioactive or hazardous materials from tank 241-AY-102 to atmosphere due to flammable gas deflagration	Pumping of more solids than anticipated, annulus cooling not adequate, waste is overheated causing a tank bump that results in gas release event with ignition	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S3	F0	E3
C106PHASE-1-I-04	---	Tank waste	Release of liquid waste into annulus of receiver DST due to tank equipment penetrating tank liner	Distributor/drop leg breaks off dropping into tank and penetrates tank liner resulting in leakage to annulus	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S0	F0	E0

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-I-05	23X	Toxic gasses	Release of toxic material from tank 241-AY-102 to the atmosphere due to mixing of incompatible material	Waste transfer reacts with waste in tank resulting in the release of toxic gasses	None Required	None Required	None Required	None Required	No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the hazard analysis database is left blank.	S2	F0	E2
C106PHASE-1-I-06	33CX	Tank waste	Release of radioactive or hazardous material from slurry receiver tank to the ground surface due to overfilling	Unlimited sluicing and slurry transfer overfills receiver tank with overflow through pit to ground	None	None	None	AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak.	S2	F3	E2
C106PHASE-1-I-07	33CX	Tank waste	Release of radioactive or hazardous material from slurry receiver tank to the ground surface due to overfilling	Line flush overfills receiver tank with overflow through pit to ground	None	AC: Tank Service Water Intrusion Mon Programs	None	AC: Trans Cntrls AC: Emergency Prep AC: Process Instrument/Measure/Test Equip AC: Safety Management Programs (Radiation Protection)	Controls based on analyzed accident, Waste Transfer Leak	S2	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons
C106PHASE-1-J-01	05X	Tank headspace aerosols and HEPA filter loading.	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	In-tank instrumentation fails causing a spark which ignites flammable gas causing damage to the ventilation system	SS: Vent Syss	LCO: SST Vent Syss-Passive: AC: Flammability Cntrls AC: Ign Cntrls AC: Flamm Gas Mon Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K.	S2	F2	E2
C106PHASE-1-J-02	04X	Tank headspace aerosols and HEPA filter loading	Release of radioactive or hazardous material from 241-AY-102 to the atmosphere due to a flammable gas deflagration	In-tank instrumentation fails causing a spark which ignites flammable gas causing damage to the ventilation system	SC: DST/AWF Primary Tank Vent Syss	LCO: DST/AWF Vent Syss AC: Flammability Cntrls AC: Ign Cntrls AC: Trans Cntrls AC: Process Instrument/Measure/Test Equip	None	AC: Emergency Prep AC: HEPA Filter Cntrls	Controls based on SB, FSAR Appendix K	S2	F3	E2

Table 5-1. Allocated Controls for Hazards Associated with Phase 1 Retrieval of Single-Shell Tank 241-C-106 Waste for Closure Using Enhanced Sluicing. (36 sheets)

ID	Rep Acc	Material at Risk	Hazardous Condition	Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Initial Safety Cons NC	Initial Freq NC	Env Cons

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AC = administrative control.
CAM = continuous air monitor.
FSAR = *Tank Farms Final Safety Analysis Report*.
GRE = gas release event.
HEPA = high-efficiency particulate air.
ID = identification.
LCO = limited condition for operation.
NA = not applicable.
NC = no control.
SB = safety basis.
SER = safety evaluation report.
SS = safety-significant.
SSC = structures, systems, and components.
SST = single-shell tank.
TFC = Tank Farm Contractor.
TSR = technical safety requirement.

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APPENDIX A

UNIT-LITER DOSE CALCULATIONS

The following information is derived from the best-basis inventory (BBI) information presented in Appendix F.

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Table A-1. 241-C-106 Supernatant Unit-Liter Dose Prior to Retrieval.

Isotope[1]	Volume[2] (L)	Inventory[3] (Ci)	Inventory[4] (Ci/L)	Inventory[5] (Bq/L)	Onsite ULD		Offsite ULD	
					DCF[6] (Sv/Bq)	ULD[7] (Sv/L)	DCF[8] (Sv/Bq)	ULD[9] (Sv/L)
^{60}Co	1.15E+05	1.16E+00	1.01E-05	3.73E+05	1.70E-08	6.34E-03	1.00E-08	3.73E-03
^{90}SR	1.15E+05	3.43E+02	2.98E-03	1.10E+08	3.00E-08	3.31E+00	3.60E-08	3.97E+00
^{90}Y	1.15E+05	3.43E+02	2.98E-03	1.10E+08	1.70E-09	1.88E-01	1.50E-09	1.66E-01
^{137}CS	1.15E+05	6.16E+03	5.36E-02	1.98E+09	6.70E-09	1.33E+01	4.60E-09	9.12E+00
^{154}Eu	1.15E+05	3.21E+00	2.79E-05	1.03E+06	3.50E-08	3.61E-02	5.30E-08	5.47E-02
^{237}Np	1.15E+05	9.66E-02	8.40E-07	3.11E+04	1.50E-05	4.66E-01	2.30E-05	7.15E-01
^{238}Pu	1.15E+05	2.12E-02	1.84E-07	6.82E+03	3.00E-05	2.05E-01	4.60E-05	3.14E-01
$^{239/240}Pu$	1.15E+05	4.57E-01	3.97E-06	1.47E+05	3.20E-05	4.71E+00	5.00E-05	7.35E+00
^{241}Pu	1.15E+05	1.12E+00	9.74E-06	3.60E+05	5.80E-07	2.09E-01	9.00E-07	3.24E-01
^{241}Am	1.15E+05	5.36E-02	4.66E-07	1.72E+04	2.70E-05	4.66E-01	4.20E-05	7.24E-01
^{244}Cm	1.15E+05	2.10E-02	1.83E-07	6.76E+03	1.70E-05	1.15E-01	2.70E-05	1.82E-01
					Total ULD	**2.30E+01**		**2.29E+01**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

2 Total volume is from the BBI as of December 18, 2002.

3 Total inventory (Ci) of the select isotope is from the BBI as of December 18, 2002.

4 This column is calculated from the total inventory (column 3) divided by the total volume (column 2).

5 This column is calculated from the inventory in Ci/L (column 4) multiplied by 3.7E+10 Bq/Ci.

6 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 µm AMAD.

7 The onsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 6).

8 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.

9 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 8).

AMAD= Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-2. 241-C-106 Sludge Unit-liter Dose Prior to Retrieval.

Isotope[1]	Volume[2] (L)	Inventory[3] (Ci)	Inventory[4] (Ci/L)	Inventory[5] (Bq/L)	Onsite ULD		Offsite ULD	
					DCF[6] (Sv/Bq)	ULD[7] (Sv/L)	DCF[8] (Sv/Bq)	ULD[9] (Sv/L)
^{60}Co	2.30E+04	2.46E-01	1.07E-05	3.96E+05	1.70E-08	6.73E-03	1.00E-08	3.96E-03
^{90}SR	2.30E+04	2.82E+05	1.23E+01	4.54E+11	3.00E-08	1.36E+04	3.60E-08	1.63E+04
^{90}Y	2.30E+04	2.82E+05	1.23E+01	4.54E+11	1.70E-09	7.71E+02	1.50E-09	6.80E+02
^{137}CS	2.30E+04	1.14E+04	4.96E-01	1.83E+10	6.70E-09	1.23E+02	4.60E-09	8.44E+01
^{154}Eu	2.30E+04	2.64E+02	1.15E-02	4.25E+08	3.50E-08	1.49E+01	5.30E-08	2.25E+01
^{237}Np	2.30E+04	1.66E-01	7.22E-06	2.67E+05	1.50E-05	4.01E+00	2.30E-05	6.14E+00
^{238}Pu	2.30E+04	3.48E+00	1.51E-04	5.60E+06	3.00E-05	1.68E+02	4.60E-05	2.58E+02
$^{239/240}Pu$	2.30E+04	9.06E+01	3.94E-03	1.46E+08	3.20E-05	4.66E+03	5.00E-05	7.29E+03
^{241}Pu	2.30E+04	1.84E+02	8.00E-03	2.96E+08	5.80E-07	1.72E+02	9.00E-07	2.66E+02
^{241}Am	2.30E+04	2.25E+02	9.78E-03	3.62E+08	2.70E-05	9.77E+03	4.20E-05	1.52E+04
^{244}Cm	2.30E+04	5.82E-01	2.53E-05	9.36E+05	1.70E-05	1.59E+01	2.70E-05	2.53E+01
					Total ULD	**2.93E+04**		**4.02E+04**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

2 Total volume is from the BBI as of December 18, 2002.

3 Total inventory (Ci) of the select isotope is from the BBI as of December 18, 2002.

4 This column is calculated from the total inventory (column 3) divided by the total volume (column 2).

5 This column is calculated from the inventory in Ci/L (column 4) multiplied by 3.7E+10 Bq/Ci.

6 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 μm AMAD.

7 The onsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 6).

8 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.

9 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 8).

AMAD = Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-3. 241-AN-106 Supernatant Unit-liter Dose Prior to Retrieval of 241-C-106 Waste.

Isotope[1]	Volume[2] (L)	Inventory[3] (Ci)	Inventory[4] (Ci/L)	Inventory[5] (Bq/L)	Onsite ULD		Offsite ULD	
					DCF[6] (Sv/Bq)	ULD[7] (Sv/L)	DCF[8] (Sv/Bq)	ULD[9] (Sv/L)
^{60}Co	1.10E+05	3.34E-01	3.04E-06	1.12E+05	1.70E-08	1.91E-03	1.00E-08	1.12E-03
^{90}SR	1.10E+05	2.74E+00	2.49E-05	9.22E+05	3.00E-08	2.76E-02	3.60E-08	3.32E-02
^{90}Y	1.10E+05	2.74E+00	2.49E-05	9.22E+05	1.70E-09	1.57E-03	1.50E-09	1.38E-03
^{137}CS	1.10E+05	5.57E+03	5.06E-02	1.87E+09	6.70E-09	1.26E+01	4.60E-09	8.62E+00
^{154}Eu	1.10E+05	7.24E+00	6.58E-05	2.44E+06	3.50E-08	8.52E-02	5.30E-08	1.29E-01
^{237}Np	1.10E+05	4.37E-02	3.97E-07	1.47E+04	1.50E-05	2.20E-01	2.30E-05	3.38E-01
^{238}Pu	1.10E+05	2.84E-03	2.58E-08	9.55E+02	3.00E-05	2.87E-02	4.60E-05	4.39E-02
$^{239/240}$ Pu	1.10E+05	9.84E-02	8.95E-07	3.31E+04	3.20E-05	1.06E+00	5.00E-05	1.65E+00
^{241}Pu	1.10E+05	1.46E-01	1.33E-06	4.91E+04	5.80E-07	2.85E-02	9.00E-07	4.42E-02
^{241}Am	1.10E+05	4.56E-01	4.15E-06	1.53E+05	2.70E-05	4.14E+00	4.20E-05	6.44E+00
^{244}Cm	1.10E+05	4.61E-07	4.19E-12	1.55E-01	1.70E-05	2.64E-06	2.70E-05	4.19E-06
					Total ULD	**1.81E+01**		**1.73E+01**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

2 Total volume is from the BBI as of December 18, 2002.

3 Total inventory (Ci) of the select isotope is from the BBI as of December 18, 2002.

4 This column is calculated from the total inventory (column 3) divided by the total volume (column 2).

5 This column is calculated from the inventory in Ci/L (column 4) multiplied by 3.7E+10 Bq/Ci.

6 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 μm AMAD.

7 The onsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 6).

8 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.

9 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 8).

AMAD= Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-4. 241-AN-106 Saltcake Unit-liter Dose Prior to Retrieval of 241-C-106 Waste.

Isotope[1]	Volume[2] (L)	Inventory[3] (Ci)	Inventory[4] (Ci/L)	Inventory[5] (Bq/L)	Onsite ULD		Offsite ULD	
					DCF[6] (Sv/Bq)	ULD[7] (Sv/L)	DCF[8] (Sv/Bq)	ULD[9] (Sv/L)
^{60}Co	6.50E+04	1.70E+00	2.62E-05	9.68E+05	1.70E-08	1.65E-02	1.00E-08	9.68E-03
^{90}SR	6.50E+04	3.56E+03	5.48E-02	2.03E+09	3.00E-08	6.08E+01	3.60E-08	7.30E+01
^{90}Y	6.50E+04	3.56E+03	5.48E-02	2.03E+09	1.70E-09	3.44E+00	1.50E-09	3.04E+00
^{137}CS	6.50E+04	1.53E+04	2.35E-01	8.71E+09	6.70E-09	5.84E+01	4.60E-09	4.01E+01
^{154}Eu	6.50E+04	2.72E+01	4.18E-04	1.55E+07	3.50E-08	5.42E-01	5.30E-08	8.21E-01
^{237}Np	6.50E+04	2.11E-02	3.25E-07	1.20E+04	1.50E-05	1.80E-01	2.30E-05	2.76E-01
^{238}Pu	6.50E+04	2.09E+00	3.22E-05	1.19E+06	3.00E-05	3.57E+01	4.60E-05	5.47E+01
$^{239/240}$ Pu	6.50E+04	7.23E+01	1.11E-03	4.12E+07	3.20E-05	1.32E+03	5.00E-05	2.06E+03
^{241}Pu	6.50E+04	1.08E+02	1.66E-03	6.15E+07	5.80E-07	3.57E+01	9.00E-07	5.53E+01
^{241}Am	6.50E+04	9.48E+00	1.46E-04	5.40E+06	2.70E-05	1.46E+02	4.20E-05	2.27E+02
^{244}Cm	6.50E+04	6.39E-05	9.83E-10	3.64E+01	1.70E-05	6.18E-04	2.70E-05	9.82E-04
					Total ULD	**1.66E+03**		**2.51E+03**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

2 Total volume is from the BBI as of December 18, 2002.

3 Total inventory (Ci) of the select isotope is from the BBI as of December 18, 2002.

4 This column is calculated from the total inventory (column 3) divided by the total volume (column 2).

5 This column is calculated from the inventory in Ci/L (column 4) multiplied by 3.7E+10 Bq/Ci.

6 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 μm AMAD.

7 The onsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 6).

8 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.

9 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 8).

AMAD= Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-5. 241-AY-102 Supernatant Unit-liter Dose Prior to Retrieval of 241-C-106 Waste.

Isotope[1]	Volume[2] (L)	Inventory[3] (Ci)	Inventory[4] (Ci/L)	Inventory[5] (Bq/L)	Onsite ULD		Offsite ULD	
					DCF[6] (Sv/Bq)	ULD[7] (Sv/L)	DCF[11] (Sv/Bq)	ULD[12] (Sv/L)
^{60}Co	1.92E+06	1.04E+01	5.41E-06	2.00E+05	1.70E-08	3.40E-03	1.00E-08	2.00E-03
^{90}SR	1.92E+06	3.08E+03	1.60E-03	5.92E+07	3.00E-08	1.78E+00	3.60E-08	2.13E+00
^{90}Y	1.92E+06	3.08E+03	1.60E-03	5.92E+07	1.70E-09	1.01E-01	1.50E-09	8.88E-02
^{137}CS	1.92E+06	5.53E+04	2.87E-02	1.06E+09	6.70E-09	7.13E+00	4.60E-09	4.89E+00
^{154}Eu	1.92E+06	2.88E+01	1.50E-05	5.54E+05	3.50E-08	1.94E-02	5.30E-08	2.94E-02
^{237}Np	1.92E+06	8.68E-01	4.51E-07	1.67E+04	1.50E-05	2.50E-01	2.30E-05	3.84E-01
^{238}Pu	1.92E+06	7.12E-01	3.70E-07	1.37E+04	3.00E-05	4.11E-01	4.60E-05	6.30E-01
$^{239/240}Pu$	1.92E+06	4.94E+00	2.57E-06	9.50E+04	3.20E-05	3.04E+00	5.00E-05	4.75E+00
^{241}Pu	1.92E+06	1.12E+01	5.82E-06	2.15E+05	5.80E-07	1.25E-01	9.00E-07	1.94E-01
^{241}Am	1.92E+06	4.83E-01	2.51E-07	9.29E+03	2.70E-05	2.51E-01	4.20E-05	3.90E-01
^{244}Cm	1.92E+06	1.17E-03	6.08E-10	2.25E+01	1.70E-05	3.83E-04	2.70E-05	6.08E-04
					Total ULD	**1.31E+01**		**1.35E+01**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

2 Total volume is from the BBI as of December 18, 2002.

3 Total inventory (Ci) of the select isotope is from the BBI as of December 18, 2002.

4 This column is calculated from the total inventory (column 3) divided by the total volume (column 2).

5 This column is calculated from the inventory in Ci/L (column 4) multiplied by 3.7E+10 Bq/Ci.

6 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 μm AMAD.

7 The onsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 6).

8 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.

9 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 8).

AMAD= Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-6. 241-AY-102 Sludge Liquid Unit-liter Dose.

Isotope[1]	Volume[2] (L)	Inventory[3] (Ci)	Inventory[4] (Ci/L)	Inventory[5] (Bq/L)	Onsite ULD		Offsite ULD	
					DCF[6] (Sv/Bq)	ULD[7] (Sv/L)	DCF[11] (Sv/Bq)	ULD[12] (Sv/L)
^{60}Co	9.70E+04	6.18E-02	6.37E-07	2.36E+04	1.70E-08	4.01E-04	1.00E-08	2.36E-04
^{90}SR	9.70E+04	1.19E+03	1.23E-02	4.54E+08	3.00E-08	1.36E+01	3.60E-08	1.63E+01
^{90}Y	9.70E+04	1.19E+03	1.23E-02	4.54E+08	1.70E-09	7.72E-01	1.50E-09	6.81E-01
^{137}CS	9.70E+04	0.00E+00	0.00E+00	0.00E+00	6.70E-09	0.00E+00	4.60E-09	0.00E+00
^{154}Eu	9.70E+04	2.66E+00	2.74E-05	1.01E+06	3.50E-08	3.55E-02	5.30E-08	5.38E-02
^{237}Np	9.70E+04	1.47E-03	1.52E-08	5.61E+02	1.50E-05	8.41E-03	2.30E-05	1.29E-02
^{238}Pu	9.70E+04	1.94E-02	2.00E-07	7.40E+03	3.00E-05	2.22E-01	4.60E-05	3.40E-01
$^{239/240}Pu$	9.70E+04	4.37E-01	4.51E-06	1.67E+05	3.20E-05	5.33E+00	5.00E-05	8.33E+00
^{241}Pu	9.70E+04	1.02E+00	1.05E-05	3.89E+05	5.80E-07	2.26E-01	9.00E-07	3.50E-01
^{241}Am	9.70E+04	1.24E+00	1.28E-05	4.73E+05	2.70E-05	1.28E+01	4.20E-05	1.99E+01
^{244}Cm	9.70E+04	3.17E-03	3.27E-08	1.21E+03	1.70E-05	2.06E-02	2.70E-05	3.26E-02
					Total ULD	**3.30E+01**		**4.60E+01**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

2 Total volume is from the BBI as of December 18, 2002.

3 Total inventory (Ci) of the select isotope is from the BBI as of December 18, 2002.

4 This column is calculated from the total inventory (column 3) divided by the total volume (column 2).

5 This column is calculated from the inventory in Ci/L (column 4) multiplied by 3.7E+10 Bq/Ci.

6 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 μm AMAD.

7 The onsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 6).

8 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.

9 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 8).

AMAD= Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-7. 241-AY-102 Sludge Unit-liter Dose.

Isotope[1]	Volume[2] (L)	Inventory[3] (Ci)	Inventory[4] (Ci/L)	Inventory[5] (Bq/L)	Onsite ULD		Offsite ULD	
					DCF[6] (Sv/Bq)	ULD[7] (Sv/L)	DCF[8] (Sv/Bq)	ULD[9] (Sv/L)
^{60}Co	5.48E+05	5.81E-01	1.06E-06	3.92E+04	1.70E-08	6.67E-04	1.00E-08	3.92E-04
^{90}SR	5.48E+05	5.27E+06	9.62E+00	3.56E+11	3.00E-08	1.07E+04	3.60E-08	1.28E+04
^{90}Y	5.48E+05	5.27E+06	9.62E+00	3.56E+11	1.70E-09	6.05E+02	1.50E-09	5.34E+02
^{137}CS	5.48E+05	1.61E+05	2.94E-01	1.09E+10	6.70E-09	7.28E+01	4.60E-09	5.00E+01
^{154}Eu	5.48E+05	6.77E+03	1.24E-02	4.57E+08	3.50E-08	1.60E+01	5.30E-08	2.42E+01
^{237}Np	5.48E+05	3.95E+00	7.21E-06	2.67E+05	1.50E-05	4.00E+00	2.30E-05	6.13E+00
^{238}Pu	5.48E+05	5.26E+02	9.60E-04	3.55E+07	3.00E-05	1.07E+03	4.60E-05	1.63E+03
$^{239/240}Pu$	5.48E+05	2.00E+03	3.65E-03	1.35E+08	3.20E-05	4.32E+03	5.00E-05	6.75E+03
^{241}Pu	5.48E+05	4.42E+03	8.07E-03	2.98E+08	5.80E-07	1.73E+02	9.00E-07	2.69E+02
^{241}Am	5.48E+05	7.62E+03	1.39E-02	5.14E+08	2.70E-05	1.39E+04	4.20E-05	2.16E+04
^{244}Cm	5.48E+05	3.03E+01	5.53E-05	2.05E+06	1.70E-05	3.48E+01	2.70E-05	5.52E+01
					Total ULD	**3.09E+04**		**4.37E+04**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

2 Total volume is from the BBI as of December 18, 2002.

3 Total inventory (Ci) of the select isotope is from the BBI as of December 18, 2002.

4 This column is calculated from the total inventory (column 3) divided by the total volume (column 2).

5 This column is calculated from the inventory in Ci/L (column 4) multiplied by 3.7E+10 Bq/Ci.

6 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 μm AMAD.

7 The onsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 6).

8 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.

9 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 5) by the DCF (column 8).

AMAD= Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-8. Unit-liter Dose Summary Prior to 241-C-106 Retrieval.

Tank	Waste phase	ULD, onsite Sv/L	ULD, offsite Sv/L
241-C-106	Supernatant	2.30E+01	2.29E+01
	Sludge	2.93E+04	4.02E+04
241-AN-106	Supernatant	1.81E+01	1.73E+01
	Saltcake	1.66E+03	2.51E+03
241-AY-102	Supernatant	1.31E+01	1.35E+01
	Sludge Liquid	3.30E+01	4.60E+01
	Sludge	3.09E+04	4.37E+04

Note:
ULD = unit-liter dose.

Table A-9. Combined Supernatant, 241-C-106 Plus 241-AN-106 Unit-liter Dose.

Isotope[1]	Supernatant volume			Supernatant inventory[3]			Inventory[8] (Ci/L)	Inventory[9] (Bq/L)	Onsite supernatant ULD		Offsite supernatant ULD	
	Volume[2] 241-C-106 (L)	Volume[3] 241-AN-106 (L)	Total volume[4] (L)	Inventory[5] 241-C-106 (Ci)	Inventory[6] 241-AN-106 (Ci)	Total inventory[7] (Ci)			Onsite DCF[10] Sv/Bq	ULD[11] (Sv/L)	Offsite DCF[12] (Sv/Bq)	ULD[13] (Sv/L)
^{60}Co	1.15E+05	1.10E+05	2.25E+05	1.16E+00	3.34E-01	1.49E+00	6.64E-06	2.46E+05	1.70E-08	4.18E-03	1.00E-08	2.46E-03
^{90}SR	1.15E+05	1.10E+05	2.25E+05	3.43E+02	2.74E+00	3.46E+02	1.54E-03	5.69E+07	3.00E-08	1.71E+00	3.60E-08	2.05E+00
^{90}Y	1.15E+05	1.10E+05	2.25E+05	3.43E+02	2.74E+00	3.46E+02	1.54E-03	5.69E+07	1.70E-09	9.67E-02	1.50E-09	8.53E-02
^{137}CS	1.15E+05	1.10E+05	2.25E+05	6.16E+03	5.57E+03	1.17E+04	5.21E-02	1.93E+09	6.70E-09	1.29E+01	4.60E-09	8.87E+00
^{154}Eu	1.15E+05	1.10E+05	2.25E+05	3.21E+00	7.24E+00	1.05E+01	4.64E-05	1.72E+06	3.50E-08	6.01E-02	5.30E-08	9.11E-02
^{237}Np	1.15E+05	1.10E+05	2.25E+05	9.66E-02	4.37E-02	1.40E-01	6.24E-07	2.31E+04	1.50E-05	3.46E-01	2.30E-05	5.31E-01
^{238}Pu	1.15E+05	1.10E+05	2.25E+05	2.12E-02	2.84E-03	2.40E-02	1.07E-07	3.95E+03	3.00E-05	1.19E-01	4.60E-05	1.82E-01
$^{239/240}$Pu	1.15E+05	1.10E+05	2.25E+05	4.57E-01	9.84E-02	5.55E-01	2.47E-06	9.13E+04	3.20E-05	2.92E+00	5.00E-05	4.57E+00
^{241}Pu	1.15E+05	1.10E+05	2.25E+05	1.12E+00	1.46E-01	1.27E+00	5.63E-06	2.08E+05	5.80E-07	1.21E-01	9.00E-07	1.87E-01
^{241}Am	1.15E+05	1.10E+05	2.25E+05	5.36E-02	4.56E-01	5.10E-01	2.26E-06	8.38E+04	2.70E-05	2.26E+00	4.20E-05	3.52E+00
^{244}Cm	1.15E+05	1.10E+05	2.25E+05	2.10E-02	4.61E-07	2.10E-02	9.33E-08	3.45E+03	1.70E-05	5.87E-02	2.70E-05	9.32E-02
									Total ULD	**2.06E+01**		**2.02E+01**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.
2 241-C-106 volume is from the BBI as of December 18, 2002.
3 241-AN-106 volume is from the BBI as of December 18, 2002.
4 Total volume (L) is the sum of the volumes for each tank (column 2 + column 3)
5 Total inventory for 241-C-106 (Ci) of the select isotope is from the BBI as of December 18, 2002.
6 Total inventory for 241-AN-106 (Ci) of the select isotope is from the BBI as of December 18, 2002.
7 Total inventory is the sum of the select inventory from each tank (column 5 + column 6).
8 This column is calculated from the total inventory (column 7) divided by the total volume (column 4).
9 This column is calculated from the inventory in Ci/L (column 8) multiplied by 3.7E+10 Bq/Ci.
10 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 μm AMAD.
11 The onsite ULD is calculated by multiplying the total inventory of the isotope Bq/L (column 9) by the DCF (column 10).
12 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.
13 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 9) by the DCF (column 12).

AMAD= Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-10. Combined Supernatant, 241-C-106 Plus 241-AY-102 Unit-liter Dose.

Isotope[1]	Supernatant volume			Supernatant inventory[3]			Inventory[8] (Ci/L)	Inventory[9] (Bq/L)	Onsite supernatant ULD		Offsite supernatant ULD	
	Volume[2] 241-C-106 (L)	Volume[3] 241-AY-102 (L)	Total volume[4] (L)	Inventory[5] 241-C-106 (Ci)	Inventory[6] 241-AY-102 (Ci)	Total inventory[7] (Ci)			Onsite DCF[10] Sv/Bq	ULD[11] (Sv/L)	Offsite DCF[12] (Sv/Bq)	ULD[13] (Sv/L)
^{60}Co	1.15E+05	1.92E+06	2.04E+06	1.16E+00	1.04E+01	1.16E+01	5.67E-06	2.10E+05	1.70E-08	3.57E-03	1.00E-08	2.10E-03
^{90}SR	1.15E+05	1.92E+06	2.04E+06	3.43E+02	3.08E+03	3.42E+03	1.68E-03	6.21E+07	3.00E-08	1.86E+00	3.60E-08	2.24E+00
^{90}Y	1.15E+05	1.92E+06	2.04E+06	3.43E+02	3.08E+03	3.42E+03	1.68E-03	6.21E+07	1.70E-09	1.06E-01	1.50E-09	9.32E-02
^{137}CS	1.15E+05	1.92E+06	2.04E+06	6.16E+03	5.53E+04	6.15E+04	3.01E-02	1.12E+09	6.70E-09	7.47E+00	4.60E-09	5.13E+00
^{154}Eu	1.15E+05	1.92E+06	2.04E+06	3.21E+00	2.88E+01	3.20E+01	1.57E-05	5.81E+05	3.50E-08	2.03E-02	5.30E-08	3.08E-02
^{237}Np	1.15E+05	1.92E+06	2.04E+06	9.66E-02	8.68E-01	9.65E-01	4.73E-07	1.75E+04	1.50E-05	2.63E-01	2.30E-05	4.03E-01
^{238}Pu	1.15E+05	1.92E+06	2.04E+06	2.12E-02	7.12E-01	7.33E-01	3.60E-07	1.33E+04	3.00E-05	3.99E-01	4.60E-05	6.12E-01
$^{239/240}$Pu	1.15E+05	1.92E+06	2.04E+06	4.57E-01	4.94E+00	5.40E+00	2.65E-06	9.79E+04	3.20E-05	3.13E+00	5.00E-05	4.90E+00
^{241}Pu	1.15E+05	1.92E+06	2.04E+06	1.12E+00	1.12E+01	1.23E+01	6.04E-06	2.24E+05	5.80E-07	1.30E-01	9.00E-07	2.01E-01
^{241}Am	1.15E+05	1.92E+06	2.04E+06	5.36E-02	4.83E-01	5.37E-01	2.63E-07	9.74E+03	2.70E-05	2.63E-01	4.20E-05	4.09E-01
^{244}Cm	1.15E+05	1.92E+06	2.04E+06	2.10E-02	1.17E-03	2.22E-02	1.09E-08	4.02E+02	1.70E-05	6.84E-03	2.70E-05	1.09E-02
									Total ULD	**1.37E+01**		**1.40E+01**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.
2 241-C-106 volume is from the BBI as of December 18, 2002.
3 241-AN-106 volume is from the BBI as of December 18, 2002.
4 Total volume (L) is the sum of the volumes for each tank (column 2 + column 3)
5 Total inventory for 241-C-106 (Ci) of the select isotope is from the BBI as of December 18, 2002.
6 Total inventory for 241-AN-106 (Ci) of the select isotope is from the BBI as of December 18, 2002.
7 Total inventory is the sum of the select inventory from each tank (column 5 + column 6).
8 This column is calculated from the total inventory (column 7) divided by the total volume (column 4).
9 This column is calculated from the inventory in Ci/L (column 8) multiplied by 3.7E+10 Bq/Ci.
10 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 μm AMAD.
11 The onsite ULD is calculated by multiplying the total inventory of the isotope Bq/L (column 9) by the DCF (column 10).
12 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.
13 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 9) by the DCF (column 12).

AMAD= Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-11. Combined Sludge, 241-C-106 Plus 241-AY-102 Unit-liter Dose.

Isotope[1]	Sludge volume			Sludge inventory[3]			Inventory[8] (Ci/L)	Inventory[9] (Bq/L)	Onsite sludge ULD		Offsite sludge ULD	
	Volume[2] 241-C-106 (L)	Volume[3] 241-AY-102 (L)	Total volume[4] (L)	Inventory[5] 241-C-106 (Ci)	Inventory[6] 241-AY-102 (Ci)	Total inventory[7] (Ci)			Onsite DCF[10] Sv/Bq	ULD[11] (Sv/L)	Offsite DCF[12] (Sv/Bq)	ULD[13] (Sv/L)
^{60}Co	2.30E+04	5.48E+05	5.71E+05	2.46E-01	5.81E-01	8.27E-01	1.45E-06	5.36E+04	1.70E-08	9.11E-04	1.00E-08	3.92E-04
^{90}SR	2.30E+04	5.48E+05	5.71E+05	2.82E+05	5.27E+06	5.55E+06	9.72E+00	3.60E+11	3.00E-08	1.08E+04	3.60E-08	1.28E+04
^{90}Y	2.30E+04	5.48E+05	5.71E+05	2.82E+05	5.27E+06	5.55E+06	9.72E+00	3.60E+11	1.70E-09	6.12E+02	1.50E-09	5.34E+02
^{137}CS	2.30E+04	5.48E+05	5.71E+05	1.14E+04	1.61E+05	1.72E+05	3.02E-01	1.12E+10	6.70E-09	7.48E+01	4.60E-09	5.00E+01
^{154}Eu	2.30E+04	5.48E+05	5.71E+05	2.64E+02	6.77E+03	7.03E+03	1.23E-02	4.56E+08	3.50E-08	1.60E+01	5.30E-08	2.42E+01
^{237}Np	2.30E+04	5.48E+05	5.71E+05	1.66E-01	3.95E+00	4.12E+00	7.21E-06	2.67E+05	1.50E-05	4.00E+00	2.30E-05	6.13E+00
^{238}Pu	2.30E+04	5.48E+05	5.71E+05	3.48E+00	5.26E+02	5.29E+02	9.27E-04	3.43E+07	3.00E-05	1.03E+03	4.60E-05	1.63E+03
$^{239/240}$Pu	2.30E+04	5.48E+05	5.71E+05	9.06E+01	2.00E+03	2.09E+03	3.66E-03	1.35E+08	3.20E-05	4.33E+03	5.00E-05	6.75E+03
^{241}Pu	2.30E+04	5.48E+05	5.71E+05	1.84E+02	4.42E+03	4.60E+03	8.06E-03	2.98E+08	5.80E-07	1.73E+02	9.00E-07	2.69E+02
^{241}Am	2.30E+04	5.48E+05	5.71E+05	2.25E+02	7.62E+03	7.85E+03	1.37E-02	5.08E+08	2.70E-05	1.37E+04	4.20E-05	2.16E+04
^{244}Cm	2.30E+04	5.48E+05	5.71E+05	5.82E-01	3.03E+01	3.09E+01	5.41E-05	2.00E+06	1.70E-05	3.40E+01	2.70E-05	5.52E+01
									Total ULD	**3.08E+04**		**4.37E+04**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.
2 241-C-106 volume is from the BBI as of December 18, 2002.
3 241-AN-106 volume is from the BBI as of December 18, 2002.
4 Total volume (L) is the sum of the volumes for each tank (column 2 + column 3)
5 Total inventory for 241-C-106 (Ci) of the select isotope is from the BBI as of December 18, 2002.
6 Total inventory for 241-AN-106 (Ci) of the select isotope is from the BBI as of December 18, 2002.
7 Total inventory is the sum of the select inventory from each tank (column 5 + column 6).
8 This column is calculated from the total inventory (column 7) divided by the total volume (column 4).
9 This column is calculated from the inventory in Ci/L (column 8) multiplied by 3.7E+10 Bq/Ci.
10 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 μm AMAD.
11 The onsite ULD is calculated by multiplying the total inventory of the isotope Bq/L (column 9) by the DCF (column 10).
12 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.
13 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 9) by the DCF (column 12).

AMAD= Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-12. Combined Solids (Sludge & Saltcake), 241-C-106 Plus 241-AN-106 Unit-liter Dose.

Isotope[1]	Solids volume			Solids inventory[3]					Onsite solids ULD		Offsite solids ULD	
	Sludge volume[2] 241-C-106 (L)	Saltcake volume[3] 241-AN-106 (L)	Total solids volume[4] (L)	Inventory[5] 241-C-106 (Ci)	Inventory[6] 241-AN-106 (Ci)	Total inventory[7] (Ci)	Inventory[8] (Ci/L)	Inventory[9] (Bq/L)	Onsite DCF[10] Sv/Bq	ULD[11] (Sv/L)	Offsite DCF[12] (Sv/Bq)	ULD[13] (Sv/L)
^{60}Co	2.30E+04	6.50E+04	8.80E+04	2.46E-01	1.70E+00	1.95E+00	2.21E-05	8.18E+05	1.70E-08	1.39E-02	1.00E-08	8.18E-03
^{90}SR	2.30E+04	6.50E+04	8.80E+04	2.82E+05	3.56E+03	2.86E+05	3.25E+00	1.20E+11	3.00E-08	3.60E+03	3.60E-08	4.32E+03
^{90}Y	2.30E+04	6.50E+04	8.80E+04	2.82E+05	3.56E+03	2.86E+05	3.25E+00	1.20E+11	1.70E-09	2.04E+02	1.50E-09	1.80E+02
^{137}CS	2.30E+04	6.50E+04	8.80E+04	1.14E+04	1.53E+04	2.67E+04	3.03E-01	1.12E+10	6.70E-09	7.52E+01	4.60E-09	5.16E+01
^{154}Eu	2.30E+04	6.50E+04	8.80E+04	2.64E+02	2.72E+01	2.91E+02	3.31E-03	1.22E+08	3.50E-08	4.29E+00	5.30E-08	6.49E+00
^{237}Np	2.30E+04	6.50E+04	8.80E+04	1.66E-01	2.11E-02	1.87E-01	2.13E-06	7.87E+04	1.50E-05	1.18E+00	2.30E-05	1.81E+00
^{238}Pu	2.30E+04	6.50E+04	8.80E+04	3.48E+00	2.09E+00	5.57E+00	6.33E-05	2.34E+06	3.00E-05	7.03E+01	4.60E-05	1.08E+02
$^{239/240}$Pu	2.30E+04	6.50E+04	8.80E+04	9.06E+01	7.23E+01	1.63E+02	1.85E-03	6.85E+07	3.20E-05	2.19E+03	5.00E-05	3.42E+03
^{241}Pu	2.30E+04	6.50E+04	8.80E+04	1.84E+02	1.08E+02	2.92E+02	3.32E-03	1.23E+08	5.80E-07	7.12E+01	9.00E-07	1.10E+02
^{241}Am	2.30E+04	6.50E+04	8.80E+04	2.25E+02	9.48E+00	2.34E+02	2.66E-03	9.86E+07	2.70E-05	2.66E+03	4.20E-05	4.14E+03
^{244}Cm	2.30E+04	6.50E+04	8.80E+04	5.82E-01	6.39E-05	5.82E-01	6.61E-06	2.45E+05	1.70E-05	4.16E+00	2.70E-05	6.61E+00
									Total ULD	**8.89E+03**		**1.24E+04**

Notes:

1 Isotopes are selected from Tables 3-1 and 3-3 of RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.
2 241-C-106 volume is from the BBI as of December 18, 2002.
3 241-AN-106 volume is from the BBI as of December 18, 2002.
4 Total volume (L) is the sum of the volumes for each tank (column 2 + column 3)
5 Total inventory for 241-C-106 (Ci) of the select isotope is from the BBI as of December 18, 2002.
6 Total inventory for 241-AN-106 (Ci) of the select isotope is from the BBI as of December 18, 2002.
7 Total inventory is the sum of the select inventory from each tank (column 5 + column 6).
8 This column is calculated from the total inventory (column 7) divided by the total volume (column 4).
9 This column is calculated from the inventory in Ci/L (column 8) multiplied by 3.7E+10 Bq/Ci.
10 The DCF is from Table 3-1 of RPP-5924, Rev. 0, for ICRP-68 and 5 μm AMAD.
11 The onsite ULD is calculated by multiplying the total inventory of the isotope Bq/L (column 9) by the DCF (column 10).
12 The DCF is from Table 3-3 of RPP-5924, Rev. 0 for ICRP-71.
13 The offsite ULD is calculated by multiplying the inventory of the isotope Bq/L (column 9) by the DCF (column 12).

AMAD= Activity Median Aerodynamic Diameter.
BBI = best-basis inventory.
DCF = dose conversion factor.
ULD = unit-liter dose.

Table A-13. Unit-liter Dose for 10% and 33% Solids Slurries.

Slurry Source Tank	Supernatant ULD		Tank Solids ULD		Slurry ULD 10% Solids 90% Supernatant		Slurry ULD 33% Solids 67% Supernatant	
	Onsite (Sv/L)	Offsite (Sv/L)	Onsite (Sv/L)	Offsite (Sv/L)	Onsite (Sv/L)	Offsite (Sv/L)	Onsite (Sv/L)	Offsite (Sv/L)
241-C-106	2.30E+01	2.29E+01	2.93E+04	4.02E+04	2.95E+03	4.04E+03	9.68E+03	1.33E+04
241-AN-106 after retrieval	2.06E+01	2.02E+01	8.89E+03	1.24E+04	9.08E+02	1.26E+03	2.95E+03	4.11E+03
241-AY-102after retrieval	1.37E+01	1.40E+01	3.08E+04	4.37E+04	3.09E+03	4.38E+03	1.02E+04	1.44E+04
FSAR SST (bounding)[1]	1.08E+04[2]		7.10E+05[2]		8.07E+04[2]		2.42E+05[2]	
FSAR DST (bounding)[1]	6.00E+03[2]		9.47E+05[2]		1.00E+05[2]		3.17E+05[2]	
FSAR AWF (bounding)[1]	1.55E+03[2]		1.71E+06[2]		1.72E+05[2]		5.65E+05[2]	

Notes:

1 Bounding values extracted for revised inhalation ULDs from Table 4-5, RPP-5924, 2000, *Radiological Source Terms for Tank Farms Safety Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

2 ULD values are considered bounding for both onsite and offsite releases.

AWF = aging waste facility.
DST = double-shell tank.
FSAR = Final Safety Analysis Report.
SST = single-shell tank.
ULD = unit-liter dose.

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: RPP-13557, Rev. 0, Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure

Scope of Review (e.g., document section or portion of calculation): Entire document, including calculations in Appendix A.

Yes	No	NA*	
[ ]	[ ]	[x]	1. Previous reviews are complete and cover the analysis, up to the scope of this review, with no gaps. *No other review conducted.*
[x]	[ ]	[ ]	2. Problem is completely defined.
[x]	[ ]	[ ]	3. Accident scenarios are developed in a clear and logical manner.
[x]	[ ]	[ ]	4. Analytical and technical approaches and results are reasonable and appropriate. *(ORP QAPP criterion 2.8)*
[x]	[ ]	[ ]	5. Necessary assumptions are reasonable, explicitly stated, and supported. *(ORP QAPP criterion 2.2)*
[ ]	[ ]	[x]	6. Computer codes and data files are documented. *No computer codes used.*
[x]	[ ]	[ ]	7. Data used in calculations are explicitly stated.
[x]	[ ]	[ ]	8. Bases for calculations, including assumptions and data, are consistent with the supported safety basis document (e.g., the Tank Farms Final Safety Analysis Report).
[x]	[ ]	[ ]	9. Data were checked for consistency with original source information as applicable. *(ORP QAPP criterion 2.9)*
[x]	[ ]	[ ]	10. For both qualitative and quantitative data, uncertainties are recognized and discussed, as appropriate. *(ORP QAPP criterion 2.17)*
[x]	[ ]	[ ]	11. Mathematical derivations were checked including dimensional consistency of results. *(ORP QAPP criterion 2.16)*
[ ]	[ ]	[x]	12. Models are appropriate and were used within their established range of validity or adequate justification was provided for use outside their established range of validity. *No computer models were used.*
[x]	[ ]	[ ]	13. Spreadsheet results and all hand calculations were verified.
[x]	[ ]	[ ]	14. Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information. *(ORP QAPP criterion 2.5)*
[ ]	[ ]	[x]	15. Software input is correct and consistent with the document reviewed. *No software used for any calculations*
[ ]	[ ]	[x]	16. Software output is consistent with the input and with the results reported in the document reviewed. *No software used for any calculations.*
[ ]	[ ]	[x]	17. Software verification and validation are addressed adequately. *(ORP QAPP criterion 2.6) No software used for any calculations.*
[x	[ ]	[ ]	18. Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references. *(ORP*

QAPP criterion 2.9)

[x] [ ] [ ] 19. Safety margins are consistent with good engineering practices.
[x] [ ] [ ] 20. Conclusions are consistent with analytical results and applicable limits.

[x] [ ] [ ] 21. Results and conclusions address all points in the purpose. *(ORP QAPP criterion 2.3)*
[x] [ ] [ ] 22. All references cited in the text, figures, and tables are contained in the reference list.
[x] [ ] [ ] 23. Reference citations (e.g., title and number) are consistent between the text callout and the reference list.
[x] [ ] [ ] 24. Only released (i.e., not draft) references are cited. *(ORP QAPP criterion 2.1)*
[x] [ ] [ ] 25. Referenced documents are retrievable or otherwise available.
[x] [ ] [ ] 26. The most recent version of each reference is cited, as appropriate. *(ORP QAPP criterion 2.1)*
[x] [ ] [ ] 27. There are no duplicate citations in the reference list.
[x] [ ] [ ] 28. Referenced documents are spelled out (title and number) the first time they are cited.
[x] [ ] [ ] 29. All acronyms are spelled out the first time they are used.
[x] [ ] [ ] 30. The Table of Contents is correct.
[x] [ ] [ ] 31. All figure, table, and section callouts are correct.
[x] [ ] [ ] 32. Unit conversions are correct and consistent.
[x] [ ] [ ] 33. The number of significant digits is appropriate and consistent.
[ ] [ ] [x] 34. Chemical reactions are correct and balanced. *No chemical reactions discussed.*
[x] [ ] [ ] 35. All tables are formatted consistently and are free of blank cells.
[x] [ ] [ ] 36. The document is complete (pages, attachments, and appendices) and in the proper order.
[x] [ ] [ ] 37. The document is free of typographical errors.
[x] [ ] [ ] 38. The tables are internally consistent.
[x] [ ] [ ] 39. The document was prepared in accordance with HNF-2353, Section 4.3, Attachment B, "Calculation Note Format and Preparation Instructions".
[x] [ ] [ ] Concurrence

Sheldon Stahl S.M. Stahl 4/14/03
Reviewer (Printed Name and Signature) Date

* If No or NA is chosen, provide an explanation on this form.

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APPENDIX B

HAZARD ANALYSIS TEAM BIOGRAPHIES

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APPENDIX B

HAZARD ANALYSIS TEAM BIOGRAPHIES

Team Lead

William H. Grams — B.S. in Mining Engineering; M.S. in Mechanical Engineering. Mr. Grams has more than 20 years of experience in the nuclear industry, all of it with the disposal of high- and low-level radioactive waste. He has over 16 years of experience at the Hanford Site including authorization basis (AB) assessments of new activities, accident analysis and release calculations, Unreviewed Safety Question screening and determinations, hazard assessments, and AB revisions. Other nuclear-related experience includes low-level waste certification, waste management assessments and audits, preparation of characterization requirements for low-level waste, preparation of design requirements for waste tank retrieval systems, and identification of regulatory requirements.

Team Members

Daniel J. Bishop — Over 10 years of experience at the Hanford Site Tank Farms with operational experience handling, storage, and transfer of radioactive liquid waste. Current work assignments are associated with Tank Farms Operations as a Field Work Supervisor/Person In Charge overseeing maintenance and construction-related activites.

John F. Bores — B.S. Civil Engineering, B.S. Business Management. Twenty-two years of engineering and construction experience, including nuclear facities projects such as the Basalt Waste Isolation Project, Hanford Waste Vitrification Plant Project, and Hanford Tank Farms. Current work assignment includes Quality Assurance support for capital projects associated with immobilized waste and single-shell tank waste retrieval.

Teresa E. Brighton — Over 20 years of operations experience at the Hanford Site Tank Farms, UO_3 Process Facility, and the 242-S Evaporator. Specific experience includes procedure development, evaporator control, maintenance of equipment, installation and removal of equipment in DST 241-SY-101, and installation of saltwell pumping equipment. Current work assignement includes Tank Farms Interim Stabilization Operations.

Christopher A. Burke — B.S. Mechanical Engineering. Over 7 years of experience in the nuclear industry including over 5 years at the Hanford Site Tank Farms. Specific experience includes safety basis revisions and implementation, procedure development, safety equipment list generation, readiness reviews, startup and testing of equipment. Other experience includes Tank Farms project management.

Keith E. Carpenter — B.S. Mechanical Engineering. Over 12 years experience in the design, construction, and operation of equipment related to the safe storage and transfer of radioactive waste material. Five years experience in project management of minor and major plant upgrades and systems.

Paul M. Dorsh — B.S. in Mechanical Engineering, Engineer in Training in the state of Washington. Three years of experience in the nuclear industry, all of it at the Hanford Site.

Experience includes various mechanical, pumping and piping system design, support calculations, and documents.

Christopher J. Kemp — M.S. Environmental Science. Over 18 years experience in the nuclear industry including waste disposal research, environmental regulatory permitting and negotiations with regulators, stakeholders, and Indian Tribes. Specific experience includes environmental regulatory negotiations for C Reactor "Cocooning," N Reactor Decommissioning, Canyon Disposition Initiative. Other work included safe surveillance and maintenance of PUREX, B Plant, REDOX, and numerous *Resource Conservation and Recovery Act* treatment, storage, and disposal facilities..

Ron J. Klein, Jr. — A.A./A.S. Nuclear Technology. Over 18 years of experience as a health physics technition at the Hanford Site Tank Farms, Plutonium Finishing Plant, B Plant, Tank Waste Grout Facilities, and Environmental Waste Operations. Specific experience includes saltwell pumping for Interim Stabalization. Health physics training includes identification of radiological hazards plus response actions needed for decontamination of personnel.

Daniel P. Niebuhr — Over 20 years of experience in nuclear operations, as a subject matter expert in high risk field work with an excellent safety record. Specific experience includes removal and packaging of high-level waste contaminated equipment and installation of equipment at the Hanford Site Tank Farms under a wide variety of field conditions. Current work assignment is a Tank Farms Operations Shift Manager with general experience in all aspects of tank farms operations.

John G. Propson — B.S. in Electrical Engineering, Registered Professional Engineer in the state of Washington; Mr. Propson has more than 29 years of experience in the nuclear industry. He has over 17 years of engineering experience at the Hanford Site of which 12 years were related to Tank Farm activities. Other related nuclear experience includes 12 years of engineering experience in the design, construction, operation, and maintenance of commercial nuclear power plant facilities.

Ryan D. Smith — B.S. Mechanical Engineering. Six years of experience at the Hanford Site with the last 3 years specific to Nuclear Safety and Licensing (NS&L) support. NS&L Engineer for the Interim Stabilization, Characterization, and Vadose Zone programs. Extensive knowledge in flammable gas-related issues related to pumping waste to and from tank farm facilities. Key team member in establishing the authorization basis (AB) for Interim Stabilization and reconciliation of the Los Alamos National Labs Safety Assessment with the Tank Waste Remediation Systems (TWRS) Basis for Interim Operations (BIO). Assisted in the transition of the TWRS BIO to the Final Safety Analysis Report as well as ongoing AB maintenance and clarification support.

David L. Strasser — B.S. in Chemistry. Over 13 years of experience in nuclear waste operations at the Hanford Site. Specific experience includes waste tank characterization, tank farms operations training, test engineering, SY-101 mitigation team, Tank Farms Operations Shift Manager, and Single-Shell Tank Faciltiy Manager. Current work assignment is Accelerated Retrieval and Closure Project Field Operations Manager.

APPENDIX C

DEFINITIONS

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APPENDIX C

DEFINITIONS

DEFINITIONS OF INFORMATION LISTED IN TABLE 3-1:

Process Variables: Process variables are the characteristics of a process, such as flow, pressure, or temperature used to define proper operation.

Guide Words: The guide words describe the variance in the process variable of concern such as high, low, more, or less.

DEFINITIONS OF INFORMATION LISTED IN TABLE 5-1:

Representative Accident (Rep Acc): An alpha/numeric code used to specify the analyzed accident in the FSAR. Only hazardous conditions with high safety consequence (S2 or S3) are assigned as representative accidents.

Item ID: The item identification (ID) is used to record a unique identifier for the hazardous condition.

Hazardous Condition: The hardware failures, operational faults, or conditions that could result in undesired consequences. The hazardous condition is a concise statement combining the cause, consequence, and mode of radioactive material release.

Cause: The causes that lead to the hazardous condition. Identifying causes is important to identifying potential preventive or mitigative controls or features for significant hazardous conditions as well as potential consequences. In many cases, multiple hardware or operational faults are required to produce a hazardous condition. This column identifies the sequence of hardware and operational faults required to produce the postulated hazardous condition.

Preventive Systems, Structures, and Components (SSCs): Systems, structures, and components are existing engineered features (hardware items) chosen during the control decision/allocation meetings to prevent the hazardous condition of concern. The engineered features are designated as safety-significant items for hazardous conditions that pose a significant threat to the health of facility workers and onsite personnel or safety class for hazards that pose a significant threat to offsite individuals.

Preventive Technical Safety Requirements (TSRs): Technical safety requirements are controls chosen during the control decision/allocation meetings to prevent the hazardous condition of concern.

Mitigative Systems, Structures, and Components (SSCs): Systems, structures, and components are existing engineered features (hardware items) chosen during the control

decision/allocation meetings to mitigate the hazardous condition of concern. The engineered features are designated as safety-significant items for hazardous conditions that pose a significant threat to the health of facility workers and onsite personnel or safety class for hazards that pose a significant threat to offsite individuals.

Mitigative Technical Safety Requirements (TSRs): Technical safety requirements are controls chosen during the control decision/allocation meetings to mitigate the hazardous condition of concern.

Control MEMO: The control memo captures additional information or comments related the control decision/allocation process.

Initial Safety Consequence No Controls (Cons Cat NC): The consequence category of no controls is a code designator for the level of consequence associated with a hazardous condition taking no credit for any preventive or mitigative controls. The following system is used:

S0 Negligible safety concerns for the facility worker.

S1 Potential industrial injury, low radiological or chemical exposure dose consequences to the facility worker.

S2 Potential significant radiological dose consequences or chemical exposure to onsite workers located outside the facility.

S3 Potential significant radiological dose consequences or chemical exposure to the offsite population.

Initial Frequency Category No Controls (Freq Cat NC): The frequency category of no controls is the quantitative estimate of the likelihood of the hazardous condition assuming no controls are present. The following system is used:

F3 Events that are expected to occur one or more times during the lifetime of the facility, categorized as "anticipated" events. The frequency range associated with this category is > 1E-02/yr.

F2 Events that could occur during the lifetime of the facility, but with low probability. Such events are categorized as "unlikely" and fall in the range of 1E-04/yr to 1E-02/yr.

F1 Events not expected to occur during the lifetime of the facility, categorized as "extremely unlikely." The frequency range associated with this category is 1E-06/yr to 1E-04/yr.

F0 Events categorized as "beyond extremely unlikely," with a frequency less than 1E-06/yr. Events in this category (such as meteor strike) are so unlikely they generally do not require special controls.

Environmental Category (Env Cat): The environmental consequence ranking is a "first cut," qualitative estimate of the environmental severity of the hazardous condition assuming no controls are present. The following system is used:

E0 No significant environmental effect outside the facility confinement systems.

E1 Limited environmental discharge of hazardous material outside the facility.

E2 Large environmental discharge of hazardous material within the plant site boundary.

E3 Significant environmental discharges of hazardous material outside the plant site boundary.

DEFINITIONS OF INFORMATION LISTED IN TABLE D-1:

Item ID: The item identification (ID) is used to record a unique identifier for the hazardous condition.

Node: The division of a process or activity into discrete segments is called a node. Each node represents a specific part of the process or activity. This division into nodes is designed to facilitate the hazard identification process.

Hazardous Condition: The hardware failures, operational faults, or conditions that could result in undesired consequences. The hazardous condition is a concise statement combining the cause, consequence, and mode of radioactive material release.

Cause: The causes that lead to the deviation from the process variable and resultant hazardous condition.

Consequence: The potential consequences that could result from the postulated deviation.

Suggested Systems, Structures, and Components (SSCs): Suggested systems, structures, and components are existing engineered features (hardware items) identified by the hazard and operability study (HAZOP) team that have the potential to mitigate or prevent the hazardous condition of concern. The engineered features are candidates for designation as safety-significant items for hazardous conditions that pose a significant threat to the health of facility workers and onsite personnel or safety class for hazards that pose a significant threat to offsite individuals. These items should not be construed as being the "official" controls that would eventually be credited in the safety basis.

Suggested Technical Safety Requirements (TSRs): Suggested technical safety requirements are existing controls identified by the HAZOP team that have the potential to mitigate or prevent the hazardous condition of concern. These items should not be construed as being the "official" administrative features that would eventually be credited in the safety basis.

Initial Safety Consequence Category, No Controls (Initial Safety Cons NC): The consequence category is a code designator for the level of consequence associated with a hazardous condition. The consequence ranking is a "first cut," qualitative estimate of the safety severity of the consequences assuming no controls are present. The following system is used:

S0 Negligible safety concerns for the facility worker.

S1 Potential industrial injury, low radiological or chemical exposure dose consequences to the facility worker.

S2 Potential significant radiological dose consequences or chemical exposure to onsite workers located outside the facility.

S3 Potential significant radiological dose consequences or chemical exposure to the offsite population.

Initial Frequency, No Controls (Initial Freq NC): The frequency category is a "first cut," qualitative estimate of the likelihood of the hazardous condition assuming no controls are present. The following system is used:

F3 Events that are expected to occur one or more times during the lifetime of the facility, categorized as "anticipated" events. The frequency range associated with this category is > 1E-02/yr.

F2 Events that could occur during the lifetime of the facility, but with low probability. Such events are categorized as "unlikely" and fall in the range of 1E-04/yr to 1E-02/yr.

F1 Events not expected to occur during the lifetime of the facility, categorized as "extremely unlikely." The frequency range associated with this category is 1E-06/yr to 1E-04/yr.

F0 Events categorized as "beyond extremely unlikely," with a frequency less than 1E-06/yr. Events in this category (such as meteor strike) are so unlikely they generally do not require special controls.

Environmental Consequence (Env Cons): The environmental consequence ranking is a "first cut," qualitative estimate of the environmental severity of the hazardous condition assuming no controls are present. The following system is used:

E0 No significant environmental effect outside the facility confinement systems.

E1 Limited environmental discharge of hazardous material outside the facility.

E2 Large environmental discharge of hazardous material within the plant site boundary.

E3 Significant environmental discharges of hazardous material outside the plant site boundary.

Representative Accident (Rep Acc): An initial selection by the HAZOP team of the alpha/numeric code used to specify the analyzed accident in the FSAR. Only hazardous conditions with high safety consequence (S2 or S3) are assigned as representative accidents.

Remarks: Miscellaneous observations or clarifying comments for a given item.

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APPENDIX D

CONTROL DECISION RECORD

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APPENDIX D

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-01	Release of radioactive or hazardous material from unfiltered release paths and damaged ventilation system to the atmosphere due to a flammable gas deflagration	Removal of in tank equipment (e.g., heel jet pump) causes spark and ignites flammable gas	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration.	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.1.8 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCD; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems.	RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on S8, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.
F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
Passive ventilation will be used during this activity.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-02	Release of radioactive or hazardous material from unfiltered release paths and damaged ventilation system to the atmosphere due to a flammable gas deflagration	Installation of new equipment (e.g., supernatant pump) causes spark and ignites flammable gas	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None Required	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration.	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.1.8 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCD; 3.2. 3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems.	RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on S8, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.
F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-03	Release of radioactive or hazardous material from damaged HEPA filter to atmosphere due to high temperature	Vehicle strikes object rupturing the fuel tank causing fire near the 241-C-106 passive ventilation system damaging the HEPA filter	S2	F3	E2	06X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	This hazardous condition affects a passive ventilation system only. There are no SSCs for this analyzed accidents associated with passive ventilation systems

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.1.8 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, HEPA Filter Failure – Exposure to High Temperature or Pressure.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 conservatively based on analyzed accident, HEPA Filter Failure – Exposure to High Temperature or Pressure. This would be S1/E1 for a passively ventilated system.
F3 based on anticipated vehicle accident in the tank farm.
Installation activities will rely on passive ventilation. Decommissioning may have active ventilation systems.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-04	Release of radioactive or hazardous material from damaged HEP A filter to atmosphere due to high temperature	Vehicle strikes object rupturing the fuel tank causing fire near the 241-C-106 active ventilation system damaging the HEPA filter	S2	F3	E2	06X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Ventilation Stack CAM Interlock Systems	X	--	Mitigates the amount of material released by shutting down the ventilation system upon detection of radiation above a set limit.	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCD; 3.1.4 Ventilation Stack CAM Interlock Systems	Ensures operability of ventilation stack CAM interlock systems.	None
AC; 5.18 HEPA Filter Controls	Reduces consequences of a HEP A filter failure by limiting the inventory available.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, HEPA Filter Failure – Exposure to High Temperature or Pressure.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 conservatively based on analyzed accident, HEPA Filter Failure – Exposure to High Temperature or Pressure.
This would be S1/E1 for a passively ventilated system.
F3 based on anticipated vehicle accident in the tank farm.
Installation activities will rely on passive ventilation. Decommissioning may have active ventilation systems.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-05	Release of radioactive or hazardous material from damaged HEPA filter to atmosphere due to high temperature	Vehicle strikes object rupturing the fuel tank causing fire near the receiver DST ventilation system damaging the HEPA filter	S2	F3	E2	06X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Ventilation Stack CAM Interlock Systems	X	--	Mitigates the amount of material released by shutting down the ventilation system upon detection of radiation above a set limit.	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCD; 3.1.4 Ventilation Stack CAM Interlock Systems	Ensures operability of ventilation stack CAM interlock systems.	None
AC; 5.18 HEPA Filter Controls	Reduces consequences of a HEP A filter failure by limiting the inventory available.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, HEPA Filter Failure – Exposure to High Temperature or Pressure.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 conservatively based on analyzed accident, HEPA Filter Failure – Exposure to High Temperature or Pressure.
This would be S1/E1 for a passively ventilated system.
F3 based on anticipated vehicle accident in the tank farm.
Installation activities will rely on passive ventilation. Decommissioning may have active ventilation systems.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-06	Release of radioactive or hazardous material from a pit to the atmosphere due to a fire	Vehicle strikes pit rupturing the fuel tank which drains into a pit and ignites	S2	F3	E2	07X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None

Preventive TSR		
Control	Safety Function	Comments
AC; 5.10 Ignition Controls (Vehicle Controls)	Prevents vehicle fuel system damage (i.e., fuel system leaks) in the event of a collision with tank structures within the tank farms.	None

Control Memo: Controls based on analyzed accident, Fire in Contaminated Area.

Revision to Original HAZOP: None

Material At Risk: Contamination from pit.

Remarks: S2/E2 based on analyzed accident, Fire in Contaminated Area.
F3 based on anticipated vehicle accident in tank farms.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-07	Release of radioactive or hazardous materials from pit to the atmosphere due to high winds	High winds/dust devil during plug removal from pit cover or pit cover removed or equipment installation or removals	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: Contamination from pit.

Remarks: S1/E1 based on analyzed accident, Natural Phenomena – High Wind.
F3 based on anticipated high winds.
Environmental barrier is open on top. Contamination will be fixed either before cover block removal or as soon a possible. Temporary covers can be quickly installed if a dust devil is spotted or winds pick up. Training covers these eventualities.
Active ventilation may be required for work in the 241-C-106 pump pit due to high contamination level.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-ALL14.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-08	Release of radioactive or hazardous material from unfiltered release paths through damaged tank dome due to excessive loads	Worker error positions crane over 241- C-106 when lifting cover blocks or installing other on tank equipment (e.g., water skid) causing damage to the tank dome	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: SST headspace aerosols.

Remarks: S1/E1 based on limited release of tank headspace aerosols through cracks in dome filtered through soil cover.
F3 based on anticipated load drop.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-09	Release of radioactive or hazardous material from unfiltered release paths through damaged tank dome due to excessive loads	Worker error causes too much lifting force when removing stuck heel jet pump in 241-C-106 heel pit with resultant riser damage	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: SST headspace aerosols.

Remarks: S1/E1 based on limited release of tank headspace aerosols through cracks in dome filtered through soil cover.
F3 based on anticipated load drop.
To avoid this issue, an "A" frame or hydraulic jacks will be used to have better load control until the pump is broken loose.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-10	Serious injury or fatality due to overloaded crane and boom failure	Worker error cause too much lifting force when removing equipment causing crane or rigging failure	S1	F3	E0	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
AC; 5.16 Load Lifting and Dome Loading Controls (Hoisting and Rigging)	Decreases the frequency of load drops.	None

Control Memo: AC: 5.16 Load Lifting and Dome Loading Controls (Hoisting and Rigging) invoked because of the high consequence to the facility worker.

Revision to Original HAZOP: None

Material At Risk: NA

Remarks: S1 based on injury to facility worker only.
E0 based on no environmental release.
F3 based on anticipated load lifting accident.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-11	Release of radioactive or hazardous material to the atmosphere due to an unfiltered release	Worker error cause too much lifting force when removing equipment causing crane or rigging failure	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: Headspace aerosols.

Remarks: S1/E1 based on limited release from small leaks in ventilation system.
F3 based on anticipated worker error.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-12	Release of radioactive or hazardous material from the 241-C-106 heel jet pump to the ground due to a leak in the flexible receiver, or other containment device	Waste trapped in heel jet pump is released from the flexible receiver when it is lifted from the tank causing a waste leak to the ground surface	S2	F3	E2	33CX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to waste leaks	Radiation protection practices detect contamination on the soil or in structures

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Waste Transfer Leak plus additional controls related to the specific activity of removal of long-length equipment from SST 241-C-106 as documented in the SER, Ref. Letter from R. J. Schepens, ORP, to E. S. Aromi, CHG, DOE-ORP: 02-TED-032, "CONTRACT NO. DE-AC27-99RL14047 -Approval of Long-Length Equipment Removal Activities for Single-Shell Tank (SST) 241-C-106."

Revision to Original HAZOP: Consequence changed to S2

Material At Risk: Tank waste.

Remarks: S21E2 based on Safety Evaluation Report (SER) (Ref. Letter from R. I. Schepens, ORP, to E. S. Aromi, CHG, DOE-ORP: 02-TED-032, "CONTRACT NO. DE-AC27-99RL14047 - Approval of Long-Length Equipment Removal Activities for Single-Shell Tank (SST) 241-C-106").

F3 based on process knowledge and tank farms operating history showing waste collection in pumps and other hollow tank equipment.

The SER requires the following controls specific to removal of equipment from 241-C-106:

> The receiver bag to be used for the heel pump will be designed and constructed of material of sufficient strength to contain the MAR resulting from postulated failures of equipment (i. e., the heel pump flexible hose and 590 lb of waste). The design and material of the receiver bag as described by drawing H-2-79350, "TWRS 70' Flexible Receiver Bag Assy for 42" Riser," will be verified by mock-up testing. To ensure receiver bags have not degraded during storage, the receiver bag used shall have been storage less than seven years and protected from ultraviolet light.

This hazardous condition was evaluated by USQ TF-03-001, Rev. 0.

This hazardous condition was mapped to REP-ACC 33C based on the SER analysis showing that this accident bounds the release.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-13	Release of radioactive or hazardous material from ruptured 241-C-106 dome to the atmosphere due to load drop	Rigging failure caused load drop when removing the 241-C-106 heel jet which falls from height sufficient to clear vertically oriented disposal container	S2	F2	E2	12BX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
AC: 5.16 Load Lifting and Dome Loading Controls	Prevents load drop accidents by decreasing the frequency of occurrence and limits load handling over a tank so that in the event the load is dropped, the tank dome would not collapse.	Because of the high lift height to clear the vertical storage container, the consequence analysis, which involves lifting a mixer pump may be invalidated.

Control Memo: Controls based on SER, Ref. Letter from R. J. Schepens, ORP, to E. S. Aromi, CHG, DOE-ORP: 02-TED-032, "CONTRACT NO. DE-AC27-99RL14047 -Approval of Long-Length Equipment Removal Activities for Single-Shell Tank (SST) 241-C-106."

Revision to Original HAZOP: This is a new hazardous condition identified during subsequent work package preparation for removal of long-length equipment

Material At Risk: Tank waste.

Remarks: S2/E2 based on Safety Evaluation Report (SER) (Ref. Letter from R. J. Schepens, ORP, to E. S. Aromi, CHG, DOE-ORP: 02-TED-032, "CONTRACT NO. DE-AC27-99RL14047 - Approval of Long-Length Equipment Removal Activities for Single-Shell Tank (SST) 241-C-106").

F2 based on frequency of occurrence for a single lift as documented in Section 3.4. 2. 1 of the FSAR.

The SER requires the following additional controls specific to removal of equipment from 241-C-106:

- AC 5.16. 2a. d. is applicable, which states, "For mechanically lifted loads within 20 ft of SST (100 Series), DST, and AWF tanks, the lower equipment boundary of the lifted item (e.g., bottom of the cover block, thermocouple tree) shall be less than 20 ft above surface grade, or pit floor above a WASTE storage tank (covered or uncovered)."
- Critical lift procedures shall be used for removal of the heel pump and transfer pump from SST 241-C-106. The critical lift procedure shall not allow lifting in wind speeds that exceed 15 mph.
- The WSSP-l packaging container will be positioned such that the minimum distance from the edge of any waste tank to the container is at least equal to the length of the pump being lifted.

This hazardous condition was evaluated by USQ TF-03-001, Rev. 0.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-A-14	Release of radioactive or hazardous material from long-length equipment flexible receiver due to high wind	High wind causes damage to flexible receiver on SST 241-C-106 heel jet pump during removal causing release of trapped tank waste	S2	F3	E2	31X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on SER, Ref. Letter from R. J. Schepens, ORP, to E. S. Aromi, CHG, DOE-ORP: 02-TED-032, "CONTRACT NO. DE-AC27-99RL14047 -Approval of Long-Length Equipment Removal Activities for Single-Shell Tank (SST) 241-C-106."

Revision to Original HAZOP: This is a new hazardous condition identified during subsequent work package preparation for removal of long-length equipment

Material At Risk: Tank waste.

Remarks: S2/E2 based on Safety Evaluation Report (SER) (Ref. Letter from R. J. Schepens, ORP, to E. S. Aromi, CHG, DOE-ORP: 02-TED-032, "CONTRACT NO. DE-AC27-99RL14047 - Approval of Long-Length Equipment Removal Activities for Single-Shell Tank (SST) 241-C-106").

F3 based on analyzed accident, Natural Phenomena - High Wind.

The SER requires the following additional controls specific to removal of equipment from 241-C-106:

- The receiver bag to be used for the heel pump will be designed and constructed of material of sufficient strength to contain the MAR resulting from postulated failures of equipment (i.e., the heel pump flexible hose and 590 lb of waste). The design and material of the receiver bag as described by drawing H-2-79350, "TWRS 70' Flexible Receiver Bag Assy for 42" Riser," will be verified by mock-up testing. To ensure receiver bags have not degraded during storage, the receiver bag used shall have been storage less than seven years and protected from ultraviolet light.

This hazardous condition was evaluated by USQ TF-03-001, Rev. 0.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-B-01	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere through breached filters due to ignition of flammable gas	Gas release event induced by large water intrusion (misroute) into tank with ignition of flammable gas and resulting filter breach	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration.	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems.	RPP-13547, Rev. 0, *Evaluation of the Potential or Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.1 0 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S21E2 based on analyzed accident, flammable gas deflagration.

FI based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.

This hazardous condition derived from Project W-320 hazardous condition # W320-B-FLUSH01.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-B-02	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere through unfiltered pathways due to tank failure due to excessive loads	Leak of service water saturates soil above tank 241-C-106 causing tank overload and dome cracking	S1	F0	E1	--

(Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for FO event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank waste.

Remarks: S1/E1 based on limited release of tank headspace aerosols through cracked dome.
FO based on documented analysis WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*, Rev. 0-a. concluding water loading in soil cover is insufficient to damage dome.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-B-03	Release of liquid waste from tank 241-C-1 06 to soil subsurface due to service water leak in sluice nit	Large water intrusion resulting in high liquid level in tank and primary liner rupture	S0	F3	E2	--

(Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
	Classification			
SSC	SS	SC	Safety Function	Comments
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (SO/S1) are addressed by Environmental Controls specified in Tank Farms FSAR Section 3.3.2.3.4, Environmental Protection (Table 3.3.2.3.4-1).

Revision to Original HAZOP: None

Material At Risk: Tank waste.

Remarks: E2 consistent with small amount of waste in tank.
F3 based on based on unknown condition of waste tank above last beach line.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-B-04	Release of radioactive liquid from tank 241-C-106 to tank 241-C-105 due to large water intrusion	Intrusion of water into tank 241-C-105 from tank 241-C-106 due to cascade effect	S0	F1	E0	--

(Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for S0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: NA

Remarks:

S0 based on no worker exposure.

E0 based on no release to environment.

F1 based on a water intrusion of over 500,000 gals to reach the cascade is considered extremely unlikely.

This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL09.

241-C-105 is listed as a sound tank.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-B-05	Release of radioactive or hazardous materials from service water system to atmosphere due to spray leak from starting supernatant transfer pump in tank 241-C-106 during the flush of transfer line	Supernatant transfer pump in tank 241-C-106 is started during the flush of transfer line and flush line is filled and pressurized resulting in flushline leak or backflow into the service water system	S2	F3	E2	33DX

(Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Pressure Switch Interlock or Alarm Systems (Service Water Lines)	X	--	The safety function is to detect backflow into the piping systems physically connected to the waste transfer route, and to either interlock or alarm to alert operators to take action to shut down the transfer pump (or other motive force), thus preventing a waste leak from the transfer system, and thereby decreasing the frequency of a Waste Transfer Leak accident.	This is a mitigative SSC when the system is tested at less than full line pressure.

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Pressure Switch Interlock or Alarm Systems (Service Water Lines)	X	--	The safety function is to detect backflow into the piping systems physically connected to the waste transfer route, and to either interlock or alarm to alert operators to take action to shut down the transfer pump (or other motive force), thus preventing a waste leak from the transfer system, and thereby decreasing the frequency of a Waste Transfer Leak accident.	This is a preventive system when the system is tested at full line pressure.

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.2: Service Water Pressure Detection Systems	Ensure operability of pressure switch interlock or alarm systems.	None
AC; 5.16 Emergency Preparedness	Mitigate the consequences of a waste transfer leak (i.e., pool on or near the ground surface) by moving workers away from the waste pool.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.1.2: Service Water Pressure Detection Systems	Ensure operability of pressure switch interlock or alarm systems.	None
AC; 5.20 Transfer Pump Administrative Lock Controls	Eliminates motive force, thus preventing unplanned transfers.	None

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank waste.

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak
F3 based on anticipated worker error.
This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-FLUSH02.*
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for*

Closure.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-B-06	Release of radioactive or hazardous materials from service water system to atmosphere due to spray leak from a backflow of tank waste into the service water system	Valve alignment is incorrect or leaking valves cause waste from the supernatant transfer pump in Tank 241-C-106 to backflows into service water system resulting in waste leak	S2	F3	E2	33DX

(Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Pressure Switch Interlock or Alarm Systems (Service Water Lines)	X	--	The safety function is to detect backflow into the piping systems physically connected to the waste transfer route, and to either interlock or alarm to alert operators to take action to shut down the transfer pump (or other motive force), thus preventing a waste leak from the transfer system, and thereby decreasing the frequency of a Waste Transfer Leak accident.	This is a mitigative SSC when the system is tested at less than full line pressure.

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Pressure Switch Interlock or Alarm Systems (Service Water Lines)	X	--	The safety function is to detect backflow into the piping systems physically connected to the waste transfer route, and to either interlock or alarm to alert operators to take action to shut down the transfer pump (or other motive force), thus preventing a waste leak from the transfer system, and thereby decreasing the frequency of a Waste Transfer Leak accident.	This is a preventive system when the system is tested at full line pressure.

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.2: Service Water Pressure Detection Systems	Ensure operability of pressure switch interlock or alarm systems.	None
AC; 5.16 Emergency Preparedness	Mitigate the consequences of a waste transfer leak (i.e., pool on or near the ground surface) by moving workers away from the waste pool.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.1.2: Service Water Pressure Detection Systems	Ensure operability of pressure switch interlock or alarm systems.	None
AC; 5.20 Transfer Pump Administrative Lock Controls	Eliminates motive force, thus preventing unplanned transfers.	None

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank waste.

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak
F3 based on anticipated worker error.
This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-FLUSH02.*

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-B-07	Release of radioactive liquid from tank 241C-106 to the soil surface due to tank overflow	Large water intrusion (Service water, surface flood, cascade) or excessive transfer causing overflow of tank	S2	F1	E2	33CX

(Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.16 Emergency Preparedness	Mitigate the consequences of a waste transfer leak (i.e., pool on or near the ground surface) by moving workers away from the waste pool.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function	Comments
AC; 5.21 Tank Service Water Intrusion Monitoring Program	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	Includes visual surveillance and surveillance of service water flow totalizers or tank level systems.

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank waste.

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak

F1 based on a water intrusion or misroute of over 500,000 gal to reach the cascade is considered extremely unlikely.

This hazardous condition derived from Project W-320 hazardous condition # W320-ABCD-ALLO7.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-B-08	Release of radioactive or hazardous waste from the sluice or pump pit on 241-C-106 to the atmosphere due to hydraulic fluid fire in the pit	Rupture of a hydraulic line to the sluicing articulation actuators leaks into the 241-C-106 sluice or pump pit and is ignited releasing contamination in the pit	S2	F2	E2	07X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a fire in contaminated area.	None

Preventive TSR		
Control	Safety Function	Comments
None	--.	--.

Control Memo: Controls based on analyzed accident, Fire in Contaminated Area.

Revision to Original HAZOP: None

Material At Risk: Contamination from pit.

Remarks: S2/E2 based on analyzed accident, Fire in Contaminated Area.

F2 based on difficulty of igniting hydraulic fluid when no normal heat source is present in the pit.

The HAZOP team discounted ignition of hydraulic fluid in the tank due to the presence of large amounts of water relative to the amount of hydraulic fluid that could leak to the tank.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-B-09	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to flammable gas deflagration	A hot spot or spark from the supernatant transfer waste pump ignites flammable gas released during sluicing causing failure of the ventilation system and continued unfiltered release	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration.	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a fire in contaminated area.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCD; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems.	RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.
F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-01	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to tank dome breach from impact	During sluicing operations sluicer moves debris in waste impacting drop leg or in tank equipment which breaches dome causing unfiltered release (assumes ventilation system failure)	S1	F1	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for S1/F1 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: SST headspace aerosols

Remarks: S1/E1 based on limited amount of material that could be released through small crack or breach in dome.
F1 based on drop legs being high in head space such that any debris that could be moved that far would be very small and light and extremely unlikely to cause any damage.
This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS03.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-02	Release of radioactive or hazardous material from 241-C-106 to the soil column due to tank liner breach	Mechanical failure causes sluicer to fall puncturing tank bottom	S0	F1	E2	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (SO/S1) are addressed by Environmental Controls specified in Tank Farms FSAR Section 3.3.2.3.4, Environmental Protection (Table 3.3.2.3.4-1).

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S0 based on depth of release, which will not affect workers.
E2 based on release of tank waste to soil column.
FI based on having to completely fail large metal structure.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-03	Release of radioactive or hazardous material from 241-C-106 to the soil column due to tank liner breach	Sluice jet impinges on weak section of tank wall causing minor leak of water or tank waste behind liner and subsequent leak to soil column	S0	F2	E2	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (SO/S1) are addressed by Environmental Controls specified in Tank Farms FSAR Section 3.3.2.3.4, Environmental Protection (Table 3.3.2.3.4-1).

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S0 based on depth of release, which will not affect workers.
E2 based on release of tank waste to soil column.
F2 based on tank being at the end of design life.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-04	Release of radioactive or hazardous material from 241-C-106 to the soil column due to tank liner breach	Sluice jet impinges on flashing causing minor leak of water or tank waste behind liner and subsequent leak to soil column	S0	F3	E2	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (SO/S1) are addressed by Environmental Controls specified in Tank Farms FSAR Section 3.3.2.3.4, Environmental Protection (Table 3.3.2.3.4-1).

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S0 based on depth of release, which will not affect workers.
E2 based on release of tank waste to soil column.
F3 based on tank design where the lead flashing does not provide a seal when a jet of liquid impinges directly on the underside.
The sluicer design limits sluice nozzle from reaching horizontal. The sluicer design shows nozzle deployed lower than flashing.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-05	Transfer of contaminated sluice water to 241-C-105 due to backflow of sluice water through cascade line	Sluice jet impinges on cascade line causing water to backflow to 241-C-105	S0	F3	E0	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for S0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S0 based on no release to surface. and no dose to workers.
E0 based on no release of waste as 241-C-105 is considered to be a sound tank.
F3 based on cascade line being open and accessible by the jet with no indexing limiter.
This hazard would cause a program delay because of the prohibition of adding waste to a SST.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-06	Release of ionizing radiation and radioactive gas from tank 241-C-106 to the atmosphere due to criticality in the tank	Excessive solids in slurry flow towards supernatant transfer pump	S2	F0	E2	01X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Radioactive fission gasses

Remarks: S1/E2 based on analyzed accident, Nuclear Criticality.
F0 based on calculations found in RPP-7475, Rev. 1, *Criticality Safety Evaluation of Hanford Tank Farms Facility*, that concludes that sluicing or transfer and storage of the waste in 241-C-106 will not create the possibility of a criticality.
This hazardous condition derived from Project W -320 hazardous condition # W320-BCD- TRANS02b.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-07	Release of ionizing radiation and radioactive gas from tank 241-C-106 to the atmosphere due to criticality in the tank	Material reaches critical mass/formation during sluicing activities	S2	F0	E2	01X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Radioactive fission gasses

Remarks: S1/E2 based on analyzed accident, Nuclear Criticality.
F0 based on calculations found in RPP-7475, Rev. 1, *Criticality Safety Evaluation of Hanford Tank Farms Facility*, that concludes that sluicing or transfer and storage of the waste in 241-C-106 will not create the possibility of a criticality.
This hazardous condition derived from Project W -320 hazardous condition # W320-BCD- TRANS04.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-08	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to flammable gas deflagration	The sluicer impinging into the solids releasing a region of retained flammable gas which is then ignited	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems.	RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.

F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.

This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANSI7.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-09	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	Sluicing nozzle strikes object when being indexed causing spark and ignition of flammable gas with damage to the ventilation system	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems.	RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.
F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
The sluicer position in tank precludes striking tank wall, floor, or in-tank equipment.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-10	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	Sluice jet moves debris causing spark and flammable gas ignition with damage to the ventilation system	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems.	RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.
F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-11	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	Hydraulic reaction force of jet bends sluicing mechanism against riser causing friction when indexing and ignition of flammable gas with damage to the ventilation system	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems.	RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.
F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-12	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	Water spray through sluice nozzle cools tank headspace resulting in excessive tank vacuum damaging tank	S2	F1	E2	13X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: Tank waste.

Remarks: S2/E2 based on limited amount of material that remains in tank that could be released via a major tank structural failure.
F1 based on based on analyzed accident that found this type of failure to be extremely unlikely.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-FLUSH04.
Accident analysis specifies structural failure due to excessive pressure (vacuum) is not credible.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-13	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to vacuum induced tank damage	Water spray through anti-siphon holes causes rapid cooling of the headspace resulting in excessive tank vacuum and tank breach	S2	F1	E2	13X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: Tank waste.

Remarks: S2/E2 based on limited amount of material that remains in tank that could be released via a major tank structural failure.
F1 based on based on analyzed accident that found this type of failure to be extremely unlikely.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-FLUSH05.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-14	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to a steam bump	Sluicing reduces the confinement over a hot spot in the sludge where the temperature has reached saturation causing a localized steam eruption	S2	F0	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: HEPA loading and tank headspace aerosols

Remarks: S2/E1 based on limited release from small, localized steam release.
F0 based on report RPP-13707, Rev. 0, *Process Control Plan for Tank 241-C-106 Closure*, concluding that heat loading that would create steam eruptions is not an issue.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-15	Release of liquid waste from tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	High pressure sluice induces movement of debris present in waste which impact and breaches the tank liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	S2	F0	E2	18AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank Waste

Remarks: S2/E1 based on analyzed accident, Tank Bump.
F0 based on report RPP-13707, Rev. 0, *Process Control Plan for Tank 241-C-106 Closure*, concluding that heat loading that would create steam eruptions is not an issue.
This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS09.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-16	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere through failed filters due to condensation of vapor in head space	Condensation of vapor in head space of tank 241-C-106 resulting from the breaking off sluicer head causes large pressure drop in the dome space (sluicer failure, water hammer, thermal shock, corrosion or fatigue) causing reverse airflow and HEPA filter failure	S2	F0	E2	18BX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: HEPA filter loading and tank headspace aerosols

Remarks: S2/E1 based on analyzed accident, Unfiltered Release.
F0 based on insufficient heat loading in tank waste to raise dome space temperature above ambient service water temperature such that spray would cause a large pressure drop.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS03.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-17	Release of radioactive or hazardous materials from tank 241-C-106 sluice pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	S2	F3	E2	33AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Transfer Leak Detection Systems	X	--	Detects a leak and provides an alarm to alert operators to take mitigative action.	None
Master Pump Shutdown System	X	--	Detects transfer system leaks via leak detectors, provides an interlock to shut down the transfer pump, and provides an alarm to alert workers to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detection systems.	None
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.22 Transfer System Cover Removal Controls	Reduces exposure of facility and onsite workers to waste aerosols and direct radiation (shine and skyshine) due to leaks into transfer system structures.	None
AC; 5.24 Safety Management Programs Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Control Decision Record (con't)

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.

F3 based on anticipated jumper or connection leak.

This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS31.

The analyzed accident credits transfer system covers and above grade structures to reduce waste aerosol release by providing an impaction surface to prevent direct spray of waste into the atmosphere and provides a tortuous path for aerosol release from a structure.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-18	Release of radioactive or hazardous materials from tank 241-C-106 sluice pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	S2	F3	E2	33AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Transfer Leak Detection Systems	X	--	Detects a leak and provides an alarm to alert operators to take mitigative action.	None
Master Pump Shutdown System	X	--	Detects transfer system leaks via leak detectors, provides an interlock to shut down the transfer pump, and provides an alarm to alert workers to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detection systems.	None
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.22 Transfer System Cover Removal Controls	Reduces exposure of facility and onsite workers to waste aerosols and direct radiation (shine and skyshine) due to leaks into transfer system structures.	None
AC; 5.24 Safety Management Programs Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Control Decision Record (con't)

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.
F3 based on anticipated jumper or connection leak.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS25.
The analyzed accident credits transfer system covers and above grade structures to reduce waste aerosol release by providing an impaction surface to prevent direct spray of waste into the atmosphere and provides a tortuous path for aerosol release from a structure.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-19	Release of radioactive or hazardous material from 241-C-106 from pits and risers to the ground surface due to overfilling the tank with sluice water	Sluicing with service water for long period of time or during back flush with no or insufficient pumping causes tank overflow	S2	F2	E2	33CX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.24 Safety Management Programs Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: SST Tank Waste

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.
F2 based on having to mis-transfer over 600,000 gal of sluice water before overflowing the tank without taking credit for backflow to 241-C-105, 106 tanks through the cascade lines.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-C-20	Release of radioactive or hazardous material from 241-C-106 to the atmosphere from unfiltered release paths due to a tank pressurization	Sluice water evaporates in relatively dry headspace causing a momentary positive spike in headspace pressure releasing headspace contaminates through unfiltered leak paths	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols

Remarks: S1/E1 based on limited release due to the brief period of positive pressure and release.
F3 based on process knowledge from Project W-320, sluicing of SST 241-C-106 where tank pressure was increased (less vacuum) when sluicing was initiated quickly when the headspace atmosphere was relatively dry.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-01	Worker exposed to ionizing radiation when replacing a damaged transfer pump	Debris (e.g., tape) damages supernatant transfer pump which must be replaced causing unplanned dose to workers	S1	F3	E0	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: NA

Remarks: S1 based on worker exposure only.
E0 based on no release to environment.
F3 based on anticipated equipment failure.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-02	Worker exposed to ionizing radiation when replacing a damaged transfer pump	Electric motor hooked up backwards driving pump in reverse damages pump which must be replaced causing unplanned dose to workers	S1	F3	E0	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: NA

Remarks: S1 based on worker exposure only.
E0 based on no release to environment.
F3 based on anticipated equipment failure.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-03	Release of ionizing radiation and radioactive gas from tank 241-C-106 to the atmosphere due to criticality in the tank pump vortices	Accumulation of material in the pump vortices until critical mass condition are met	S2	F0	E2	01X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Radioactive fission gasses

Remarks: S2/E2 based on analyzed accident, Nuclear Criticality.
F0 based on calculations found in RPP-7475, Rev. 1, *Criticality Safety Evaluation of Hanford Tank Farms Facility*, that concludes that sluicing or transfer and storage of the waste in 241-C-106 will not create the possibility of a criticality. This hazardous condition derived from Project W-320 hazardous condition # W320-BCD- TRANS01.This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-04	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to flammable gas deflagration	A hot spot or spark from supernatant transfer pump ignites flammable gas released during sluicing causing failure of the ventilation system and continued unfiltered release	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration.	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems.	RPP-13547, Rev. 0, *Evaluation of the Potential or Tank 241-C-JO6 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-I 06 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank heads pace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.
F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-JO6 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-05	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to HEPA filter failure caused by high pressure	A leak in the supernatant transfer pump caused by a failed component or mis-assembly causes excessive aerosols which plug the HEPA causing failure by high differential pressure	S2	F3	E2	06X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Ventilation Stack CAM Interlock Systems	X	--	Mitigates the amount of material released by shutting down the ventilation system upon detection of radiation above a set limit.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.4 Ventilation Stack CAM Interlock Systems	Ensures operability of ventilation stack CAM interlock systems.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEPA filter failure by limiting the inventory available.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.

Revision to Original HAZOP: None

Material At Risk: Tank heads pace aerosols and HEPA filter loading.

Remarks: S2/E2 conservatively based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.
This would be S1/E1 for a passively ventilated system
F3 based on aerosol generation and filter loading during sluicing.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-06	Release of radioactive or hazardous waste from the sluice pit on 241-C-106 to the atmosphere due to hydraulic fluid fire in the pit	Rupture of a hydraulic line to the sluice nozzle indexer leaks into the 241-C-106 sluice pit and is ignited releasing contamination in the pit	S2	F2	E2	07X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a fire in contaminated area.	None

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Fire in Contaminated Area.

Revision to Original HAZOP: None

Material At Risk: Contamination from pit.

Remarks: S2/E2 based on analyzed accident, Fire in Contaminated Area.
F2 based on difficulty of igniting hydraulic fluid when no normal heat source is present in the pit.
The HAZOP team discounted ignition of hydraulic fluid in the tank due to the presence of large amounts of water relative to the amount of hydraulic fluid that could leak to the tank.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-07	Release of radioactive liquid from the receiver tank to soil subsurface due to over filling	Continued sluicing and pumping from tank 241-C-1 06 resulting in over flow of receiver tank and above ground leak of tank waste	S2	F3	E2	33CX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: SST Tank Waste.

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak

F3 based on unlimited amount of sluice water from Hanford service water system.

This hazardous condition derived from Project W-320 hazardous condition # W320-B-ALL12.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-08	Release of radioactive or hazardous materials from tank 241-C-106 pump pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	S2	F3	E2	33AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Transfer Leak Detection Systems	X	--	Detects a leak and provides an alarm to alert operators to take mitigative action.	None
Master Pump Shutdown System	X	--	Detects transfer system leaks via leak detectors, provides an interlock to shut down the transfer pump, and provides an alarm to alert workers to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detection systems.	None
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.22 Transfer System Cover Removal Controls	Reduces exposure of facility and onsite workers to waste aerosols and direct radiation (shine and skyshine) due to leaks into transfer system structures.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank Waste.

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.

F3 based on anticipated jumper or connection leak.

This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS30.

The analyzed accident credits transfer system covers and above grade structures to reduce waste aerosol release by providing an impaction surface to prevent direct spray of waste into the atmosphere and provides a tortuous path for aerosol release from a structure.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-09	Release of radioactive or hazardous materials from tank 241-C-106 pump pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	S2	F3	E2	33AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Transfer Leak Detection Systems	X	--	Detects a leak and provides an alarm to alert operators to take mitigative action.	None
Master Pump Shutdown System	X	--	Detects transfer system leaks via leak detectors, provides an interlock to shut down the transfer pump, and provides an alarm to alert workers to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detection systems.	None
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.22 Transfer System Cover Removal Controls	Reduces exposure of facility and onsite workers to waste aerosols and direct radiation (shine and skyshine) due to leaks into transfer system structures.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: SST Tank Waste.

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.
F3 based on anticipated jumper or connection leak.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS24.
The analyzed accident credits transfer system covers and above grade structures to reduce waste aerosol release by providing an impaction surface to prevent direct spray of waste into the atmosphere and provides a tortuous path for aerosol release from a structure.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-10	Release of radioactive or hazardous material from the service water lines to the surface due to a backflow of waste	Leaking valves or incorrect valve alignment causes backflow of waste into service water line during transfer pump operation with leak through unmonitored service water system	S2	F3	E2	33DX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Pressure Switch Interlock or Alarm Systems (Service Water Lines)	X	--	The safety function is to detect backflow into the piping systems physically connected to the waste transfer route, and to either interlock, or alarm to alert operators to take action to shut down the transfer pump (or other motive force), thus preventing a waste leak from the transfer system, and thereby decreasing the frequency of a Waste Transfer Leak accident.	This is a mitigative SSC when the system is tested at less than full line pressure.
Isolation Valves	X	--	Limits the misroute of waste from the physically connected transfer routs to physically disconnected portions of the facility, thus decreasing the consequence of a waste transfer leak.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Pressure Switch Interlock or Alarm Systems (Service Water Lines)	X	--	The safety function is to detect backflow into the piping systems physically connected to the waste transfer route, and to either interlock, or alarm to alert operators to take action to shut down the transfer pump (or other motive force), thus preventing a waste leak from the transfer system, and thereby decreasing the frequency of a Waste Transfer Leak accident.	This is a preventive system when the system is tested at full line pressure.

Control Decision Record (con't)

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.2 Service Water Pressure Detection System	Ensures operability of pressure switch interlock or alarm systems.	None
AC; 5.12 Waste Transfer Controls (Configuration Management, Isolation Valves and material balance)	Verities that two SS waste isolation valves are in the closed position when used to physically isolate transfer piping from the planned waste transfer route. Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.1.2 Service Water Pressure Detection System	Ensures operability of pressure switch interlock or alarm systems.	None

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank Waste.

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.

F3 based on sluice water system design taking no credit for backflow preventer.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-D-11	Release of radioactive or hazardous materials from tank 241-C-106 pump pit to atmosphere due to waste leak through the electrical connections into an electrical junction box	Electrical connector seal fault or improper assembly causes a flow of waste through the electrical cable up to the nearest junction box	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: This is a new hazardous condition identified during the run-in of the waste transfer pump

Material At Risk: SST Tank Waste.

Remarks: S1/E1 based on the limited amount of waste that can be transported through the electrical cable.
F3 based on tank farms operating experience where this condition was documented.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-01	Personnel exposure to ionizing radiation due to excavation or construction activities uncovering shielding on hose-in-hose transfer lines	Error causes removal of shielding above hose-in-hose transfer line resulting in worker exposure to ionizing radiation	S1	F3	E0	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: NA

Remarks: S1 based on worker exposure only.
E0 based on no releases.
F3 based on anticipated worker error, either in the field or office.
This hazardous condition derived from Project W-320 hazardous condition # W320-ABCD-TRANS16.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-02	Release of radioactive or hazardous material from a ruptured transfer hose to the atmosphere due to high compressed air pressure	Compressed air blowdown ruptures transfer line with release to atmosphere	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for S1/F2 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S1/E1 based on compressed air line rupture analysis.
F2 based on factor of safety of hose relative to rated pressure of portable compressors normally used in tank farms.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-03	Worker exposure to ionizing radiation due to back flow of waste into compressed air system	Radioactive liquid gravity flows into compressed air system during line blowdown activities	S1	F3	E0	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: NA

Remarks: S1 based on exposure to facility worker only.
E0 based on no release to environment.
F3 based on configuration of flush/blowdown system without controls.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-04	Worker exposure to ionizing radiation due to unplugging transfer line	Excess solids causes line plug, worker exposure clearing plug	S1	F3	E0	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: NA

Remarks: S1 based on exposure to facility worker only.
E0 based on no release to environment.
F3 based on tank farms history for plugging lines during slurry transfer.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-05	Small release of radioactive or hazardous materials from the transfer line to the atmosphere due to flammable gas deflagration in line, transfer started	Buildup of solids and flammable gas in transfer line with ignition resulting in breach of transfer line; pumping is started without knowledge of breach	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Pipe Encasements	X	--	Directs the flow of leaked waste from the primary line to a waste transfer-associated structure for detection. thus reducing the consequences.	None
Over ground Transfer System-Encasements and Connections	X	--	Directs the flow of leaked waste from the primary line to a waste transfer-associated structure for detection. thus reducing the consequences.	None
Transfer Leak Detection Systems	X	--	Provide an alarm when waste is detected in transfer related structures to alert operators to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of flammable gas.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detectio system	None
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None
AC: 5.20 Transfer Pump Administrative Lock Controls	Reduces the possibility of waste leakage accumulating in waste transfer-associated structures thereby preventing flammable gas	None

Control Decision Record (con't)

Control Memo: Controls based on SB, FSAR Appendix K.
Revision to Original HAZOP: None
Material At Risk: Tank headspace aerosols and HEPA filter loading.
Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.
F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL05.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-06	Release of radioactive or hazardous materials to the atmosphere due to flammable gas deflagration in the waste transfer line	Plugging of transfer line occurs, flammable gas builds up and is ignited resulting in a breach of transfer line; pumping is started (collection in pit)	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Pipe Encasements	X	--	Directs the flow of leaked waste from the primary line to a waste transfer-associated structure for detection. thus reducing the consequences.	None
Over ground Transfer System-Encasements and Connections	X	--	Directs the flow of leaked waste from the primary line to a waste transfer-associated structure for detection. thus reducing the consequences.	None
Transfer Leak Detection Systems	X	--	Provide an alarm when waste is detected in transfer related structures to alert operators to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of flammable gas.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detectio system	None
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None
AC: 5.20 Transfer Pump Administrative Lock Controls	Reduces the possibility of waste leakage accumulating in waste transfer-associated structures thereby preventing flammable gas	None

Control Decision Record (con't)

Control Memo: Controls based on SB, FSAR Appendix K.
Revision to Original HAZOP: None
Material At Risk: Tank headspace aerosols and HEPA filter loading.
Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.
F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-1O6 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL10.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-07	Release of radioactive or hazardous material from the receiver tank ventilation system to the atmosphere due to HEPA filter failure due to high pressure	Compressed air used to blow down transfer line exceeds the HEP A filter capacity in the receiver tank causing filter failure and release of contaminants	S2	F1	E2	06X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Ventilation Stack CAM Interlock Systems	X	--	Mitigates the amount of material released by shutting down the ventilation system upon detection of radiation above a set limit.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function	Comments
LCO; 3.1.4 Ventilation Stack CAM Interlock Systems	Ensures operability of ventilation stack CAM interlock systems.	None
AC; 5.18 HEPA Filter Controls	Reduces consequences of a HEPA filter failure by limiting the inventory available.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function.	Comments
None	--	--

Control Memo: Controls based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.
F1 based on limitation of air flow through long 2in. hose and limitation of the size of a normal portable air compressor.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-08	Personnel exposure to ionizing radiation due to high winds	High winds uncover overground transfer lines	S1	F3	E0	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: NA

Remarks: S1 based on worker exposure to ionizing radiation only.
E0 based on no release.
F3 based on anticipated high winds.
This hazardous condition derived from Project W-320 hazardous condition # W320-ABCD-TRANS15.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure.*

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-09	Release of radioactive or hazardous material to the ground surface or atmosphere from a damaged overground transfer line due to wind blown missile	Missile caused by high wind or tornado penetrates overground transfer line causing surface or spray leak	S2	F3	E2	33CX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank waste.

Remarks: S2/E2 based on analyzed accident, Natural Phenomena-High Wind.
F3 based on anticipated high winds.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-10	Release of radioactive or hazardous waste due to seismic induced damaged to a transfer line	Seismic event damages overground transfer line by ground motion resulting in spray release	S2	F2	E2	33CX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank waste.

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak
F1 based on seismic event of sufficient magnitude to damage hose-in-hose transfer line considered extremely unlikely.
This hazardous condition derived from Project W-320 hazardous condition # W320-D- TRANS11.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure.*

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-11	Release of radioactive or hazardous waste due to seismic induced damaged to a transfer line	Seismic event damages transfer line by ground motion resulting in subsurface leak remaining subsurface	S0	F2	E2	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (SO/S1) are addressed by Environmental Controls specified in Tank Farms FSAR Section 3.3.2.3.4, Environmental Protection (Table 3.3.2.3.4-1).

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S0 based on no worker exposure to a subsurface leak.
E2 based on direct leak of tank waste to soil column.
F2 based on seismic event of sufficient magnitude to damage transfer line considered extremely unlikely.
This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS11.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-12	Release of radioactive or hazardous materials or hazardous waste from transfer line in tank 241-C-106 pit to atmosphere due to leak in line flush connection	Blank flange or hose connection left off flushing connection in pit after flushing and transfer initiated.	S2	F3	E2	33AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Transfer Leak Detection Systems	X	--	Detects a leak and provides an alarm to alert operators to take mitigative action.	None
Master Pump Shutdown System	X	--	Detects transfer system leaks via leak detectors, provides an interlock to shut down the transfer pump, and provides an alarm to alert workers to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detection systems.	None
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.22 Transfer System Cover Removal Controls	Reduces exposure of facility and onsite workers to waste aerosols and direct radiation (shine and skyshine) due to leaks into transfer system structures.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Decision Record (con't)

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.
Revision to Original HAZOP: None
Material At Risk: Tank waste
Remarks: S21E2 based on analyzed accident, Waste Transfer Leak.
F3 based on anticipated worker error.
This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-TRANS11.
The analyzed accident credits transfer system covers and above grade structures to reduce waste aerosol release by providing an impaction surface to prevent direct spray of waste into the atmosphere and provides a tortuous path for aerosol release from a structure.
This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS11.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-13	Release of radioactive or hazardous materials or hazardous waste from line in pit to the surface due to leak caused by mis-positioned valve, cover plug in place	Air blow down valves left in flush configuration after flushing, cover plug remains in place on initiation of sluicing process, high-capacity drain cover left on and pit overflows.	S2	F3	E2	33AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Transfer Leak Detection Systems	X	--	Detects a leak and provides an alarm to alert operators to take mitigative action.	None
Master Pump Shutdown System	X	--	Detects transfer system leaks via leak detectors, provides an interlock to shut down the transfer pump, and provides an alarm to alert workers to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detection systems.	None
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.22 Transfer System Cover Removal Controls	Reduces exposure of facility and onsite workers to waste aerosols and direct radiation (shine and skyshine) due to leaks into transfer system structures.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Decision Record (con't)

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.
Revision to Original HAZOP: None
Material At Risk: Tank waste
Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.
F3 based on anticipated worker error.
This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-TRANS13.
The analyzed accident credits transfer system covers and above grade structures to reduce waste aerosol release by providing an impaction surface to prevent direct spray of waste into the atmosphere and provides a tortuous path for aerosol release from a structure.
This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS11.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-14	Release of radioactive or hazardous material from overground transfer hose to the ground due to a leaking connection	High temperature water flush degrades seal at hose joint connection causing leak to ground surface	S2	F3	E2	33CX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Overground Transfer system-Encasement and Connections	X	--	Works in conjunction with the transfer leak detection system to direct the flow of leaked waste to a transfer related structure for detection thus reducing the consequence of a leak.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.13 Encasement Seal Loop Controls	Ensures waste leaks from primary pipes will drain to waste transfer-associated structures.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.22 Transfer System Cover Removal Controls	Reduces exposure of facility and onsite workers to waste aerosols and direct radiation (shine and skyshine) due to leaks into transfer system structures.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Decision Record (con't)

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.
Revision to Original HAZOP: None
Material At Risk: Tank waste
Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.
F3 based on operational experience where hose-in-hose transfer lines have leaked due to degradation caused by high temperatures.
Encasement for hose-in-hose transfer line drains to a pit which, if undetected would overflow.
The design of the 241-C-106 transfer system does not include heating of flush water. Tank wastes and sluice water is well below the temperature that would cause connection failure.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-15	Release of radioactive or hazardous materials to the surface due to ruptured transfer line	Overground transfer line break due to light aircraft strike	S2	F0	E2	33CX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank waste.

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak

F0 based on aircraft crash damaging the transfer line while a transfer is in progress is considered beyond extremely unlikely.

This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS32.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-16	Release of radioactive liquid from overflow of pit on receiver DST to soil surface due to transfer line leak	Jumper break or improper installation in pit with the high capacity drain cover on resulting in overflow of pit	S2	F3	E2	33AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Transfer Leak Detection Systems	X	--	Detects a leak and provides an alarm to alert operators to take mitigative action.	None
Master Pump Shutdown System	X	--	Detects transfer system leaks via leak detectors, provides an interlock to shut down the transfer pump, and provides an alarm to alert workers to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detection systems.	None
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.22 Transfer System Cover Removal Controls	Reduces exposure of facility and onsite workers to waste aerosols and direct radiation (shine and skyshine) due to leaks into transfer system structures.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Decision Record (con't)

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.
Revision to Original HAZOP: None
Material At Risk: Tank waste
Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.
F3 based on anticipated jumper or connection leak.
This hazardous condition derived from Project W-320 hazardous condition # W320B-FLUSH06.
The analyzed accident credits transfer system covers and above grade structures to reduce waste aerosol release by providing an impaction surface to prevent direct spray of waste into the atmosphere and provides a tortuous path for aerosol release from a structure.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-17	Release of radioactive liquid from overflow of pit on receiver DST to soil surface due to transfer line leak	Jumper break or Improper installation in pit with the high capacity drain cover open and pit cover off	S2	F3	E2	33AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Transfer Leak Detection Systems	X	--	Detects a leak and provides an alarm to alert operators to take mitigative action.	None
Master Pump Shutdown System	X	--	Detects transfer system leaks via leak detectors, provides an interlock to shut down the transfer pump, and provides an alarm to alert workers to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detection systems.	None
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.22 Transfer System Cover Removal Controls	Reduces exposure of facility and onsite workers to waste aerosols and direct radiation (shine and skyshine) due to leaks into transfer system structures.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Decision Record (con't)

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.
Revision to Original HAZOP: None
Material At Risk: Tank waste
Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.
F3 based on anticipated jumper or connection leak.
This hazardous condition derived from Project W-320 hazardous condition # W320B-FLUSH06.
The analyzed accident credits transfer system covers and above grade structures to reduce waste aerosol release by providing an impaction surface to prevent direct spray of waste into the atmosphere and provides a tortuous path for aerosol release from a structure.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-E-18	Release of radioactive or hazardous materials from pit to atmosphere due to spray leak from jumper	Seismic event damages jumper and breaches cover block by ground motion resulting in spray release	S2	F1	E2	33AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Transfer Leak Detection Systems	X	--	Detects a leak and provides an alarm to alert operators to take mitigative action.	None
Master Pump Shutdown System	X	--	Detects transfer system leaks via leak detectors, provides an interlock to shut down the transfer pump, and provides an alarm to alert workers to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detection systems.	None
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.22 Transfer System Cover Removal Controls	Reduces exposure of facility and onsite workers to waste aerosols and direct radiation (shine and skyshine) due to leaks into transfer system structures.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Decision Record (con't)

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.
Revision to Original HAZOP: None
Material At Risk: Tank waste
Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.
F1 based on seismic event of sufficient magnitude to damage hose-in-hose piping considered extremely unlikely. This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS10.
The analyzed accident credits transfer system covers and above grade structures to reduce waste aerosol release by providing an impaction surface to prevent direct spray of waste into the atmosphere and provides a tortuous path for aerosol release from a structure.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-F-01	Worker exposure to ionizing radiation when changing HEPA filters in 241-C-IO4 and 241-C-105	Active ventilation system in 241-C-106 draws additional air through the cascade lines to 241-C-104 and 241-C-105 HEPAs causing additional filter changes and unplanned exposure	S1	F2	E0	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for S1/F2 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: NA

Remarks: S1 based on facility worker exposure only.
E0 based on no release to environment.
F2 based on operational history from past practice sluicing (Project W-320) showing only minimal pressure changes in cascaded tanks when active ventilation in 241-C-106 was operating.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-F-02	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere through failed filters due to moisture buildup	Moisture buildup on filters causes excessive back pressure and failure	S2	F3	E2	06X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Ventilation Stack CAM Interlock Systems	X	--	Mitigates the amount of material released by shutting down the ventilation system upon detection of radiation above a set limit.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function	Comments
LCO; 3.1.4 Ventilation Stack CAM Interlock Systems	Ensures operability of ventilation stack CAM interlock systems.	None
AC; 5.18 HEPA Filter Controls	Reduces consequences of a HEPA filter failure by limiting the inventory available.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function.	Comments
None	--	--

Control Memo: Controls based on analyzed accident, HEPA Filter Failure - Exposure to High Temperature or Pressure.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 conservatively based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.
This would be S1/E1 for a passively ventilated system.
F3 based on aerosol generation and filter loading during sluicing
If moisture generation causes moisture buildup on HEPAs, then active ventilation could be used only when visibility is poor or a moisture separation system designed for the ventilation system.
This hazardous condition derived from Project W-320 hazardous condition # W320-ALL-TRANS01.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-F-03	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to HEP A filter failure	Sluicer breaks resulting m excessive aerosol generation in head space and release through failed HEPAs caused by HEPA plugging and high differential pressure	S2	F3	E2	06X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Ventilation Stack CAM Interlock Systems	X	--	Mitigates the amount of material released by shutting down the ventilation system upon detection of radiation above a set limit.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function	Comments
LCO; 3.1.4 Ventilation Stack CAM Interlock Systems	Ensures operability of ventilation stack CAM interlock systems.	None
AC; 5.18 HEPA Filter Controls	Reduces consequences of a HEPA filter failure by limiting the inventory available.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function.	Comments
None	--	--

Control Memo: Controls based on analyzed accident, HEPA Filter Failure - Exposure to High Temperature or Pressure.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 conservatively based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure for active ventilation system.
This would be S1/E1 for a passively ventilated system.
F3 based on aerosol generation and filter loading during sluicing
If moisture generation causes moisture buildup on HEPAs, then active ventilation could be used only when visibility is poor or a moisture separation system designed for the ventilation system.
This hazardous condition derived from Project W-320 hazardous condition # W320-ALL-TRANS10.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-F-04	Release of radioactive or hazardous materials from tank 241-C-106 to soil column due to vacuum induced tank damage	Ventilation system fan on with tank level too low and or inlet damper closed results in vacuum uplift of tank bottom and leak to soil column	S0	F3	E3	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: See Environmental Controls in Tank Farms FSAR Chapter 3, paragraph 3.3.2.3.4, Environmental Compliance Program (Table 3.3.2.3.4-1).

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S0 based on no exposure to workers.
E3 based on waste leak to soil column.
F3 based on active ventilation system capable of uplifting tank bottom.
This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL03.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-F-05	Release of radioactive or hazardous materials from tanks connected 241-C-106 via cascade lines to the soil column due to vacuum induced tank damage	Ventilation system fan on with tank level too low and or inlet damper closed results in vacuum uplift of tank bottom of interconnected tanks and leak to soil column	S0	F1	E3	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (S0/S1) are addressed by Environmental Controls specified in Tank Farms FSAR Section 3.3.2.3.4, Environmental Protection (Table 3.3.2.3.4-1).

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S0 based on no exposure to workers.
E3 based on waste leak to soil column.
F1 based on flow restriction of cascade line coupled with anticipated leak paths around a closed ventilation damper plus having to have all in leakage to all cascaded tanks blocked off makes this an extremely unlikely condition.
This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL03.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-F-06	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to vacuum induced tank damage'	Fan controller failure resulting in excessive vacuum in tank, loop seal actuation and tank damage (dome damage)	S2	F0	E2	13X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank waste and headspace aerosols

Remarks: S2/E2 based on analyzed accident, Tank Failure Due to Excessive Loads
F0 based on ventilation *system* having insufficient vacuum to damage dome with no restriction or limitations on inlet damper.
This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL04.
Accident analysis specifies structural failure due to excessive pressure (vacuum) is not credible.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-F-07	Release of radioactive or hazardous materials to the atmosphere due to seismically induced structural failure of the ventilation system	Seismic event causes failure of ventilation system	S2	F1	E2	18BX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Natural Phenomena, Seismic.

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S2/E2 based on analyzed accident, Unfiltered Release.

F1 based on seismic event of sufficient magnitude to seriously damage portable ventilation system such that releases would reach the 100 meter receptor considered extremely unlikely.

This hazardous condition derived from Project W-320 hazardous condition # W320-D-ALL10.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-F-08	Release of radioactive or hazardous materials from ventilation ducting due to high winds or tornado	High winds or tornado resulting in failed ventilation ducting and unfiltered release	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Natural Phenomena-High Wind.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols.

Remarks: S1/E1 based on limited release from damaged ventilation system.

F3 based on anticipated high wind.

This hazardous condition derived from Project W-320 hazardous condition # W320-ALL-TRANS02.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-F-09	Release of radioactive or hazardous materials from tank 241-C-106 ventilation system to atmosphere due to ventilation system leak	Ducting corrosion or seal deterioration undetermined during sluicing	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols.

Remarks: S1/E1 based on limited release from small leaks in ventilation system.
F3 based on anticipated corrosion or deterioration of HEPA seals in ventilation system with a small release affecting facility worker only.
This hazardous condition derived from Project W-320 hazardous condition # W320-D-VENT07
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-F-10	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to excessive vacuum	Excessive vacuum caused by human error (closing off inlet damper) in tank from ventilation system resulting in 1000 seal failure and unfiltered release	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Radiation Protection).

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols.

Remarks: S1/E1 based on limited release through seal loop.
F3 based on ventilation having sufficient vacuum to empty seal loop.
This hazardous condition derived from Project W-320 hazardous condition # W320-D-VENT08..
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-G-01	Release of radioactive or hazardous materials from receiver DST to atmosphere due to unfiltered release through failed HEPA filter	Excessive transfer flow resulting in increased aerosol generation and which loads HEPA filters causing high differential measure and filter failure	S2	F2	E2	06X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Ventilation Stack CAM Interlock Systems	X	--	Mitigates the amount of material released by shutting down the ventilation system upon detection of radiation above a set limit.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function	Comments
LCO; 3.1.4 Ventilation Stack CAM Interlock Systems	Ensures operability of ventilation stack CAM interlock systems.	None
AC; 5.18 HEPA Filter Controls	Reduces consequences of a HEPA filter failure by limiting the inventory available.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function.	Comments
None	--	--

Control Memo: Controls based on analyzed accident, HEPA Filter Failure - Exposure to High Temperature or Pressure.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 conservatively based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure
F2 based on aerosol generation from transfer into tank unlikely to generate excessive aerosols.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS06.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-G-02	Release of radioactive or hazardous materials from receiver DST to atmosphere due to unfiltered release through failed HEPA filter	Distributor breaks off resulting in excessive aerosol generation in head space causing high differential pressure and failure of the HEPA	S2	F2	E2	06X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Ventilation Stack CAM Interlock Systems	X	--	Mitigates the amount of material released by shutting down the ventilation system upon detection of radiation above a set limit.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function	Comments
LCO; 3.1.4 Ventilation Stack CAM Interlock Systems	Ensures operability of ventilation stack CAM interlock systems.	None
AC; 5.18 HEPA Filter Controls	Reduces consequences of a HEPA filter failure by limiting the inventory available.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Preventive TSR		
Control	Safety Function.	Comments
None	--	--

Control Memo: Controls based on analyzed accident, HEPA Filter Failure - Exposure to High Temperature or Pressure.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 conservatively based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure
F2 based on aerosol generation from transfer into tank unlikely to generate excessive aerosols.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS08.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-G-03	Release of radioactive or hazardous materials from tank 241-AY-102 to atmosphere due to unfiltered release through failed HEPA filters	Heat loading from new waste cause loading of HEPA filters which fail by high differential pressure with aerosol release	S2	F0	E2	06X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 33.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: HEPA filter loading and headspace aerosols.

Remarks: S2/E2 conservatively based on analyzed accident, HEPA Filter Failure-Exposure to High Temperature or Pressure.
F0 based on 241-C-106 waste transferred into tank unlikely to generate enough heat to over-pressurize the ventilation system.
This hazardous condition derived from Project W-320 hazardous condition # W320-B- TRANS11.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-G-04	Release of radioactive or hazardous materials from tank 241-AY-102 through failed filters due to tank bump	Cold water spray into tank (possible result of waste transfer distribution) chills head space causing tank vacuum inducing resulting tank bump	S2	F0	E2	18AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 33.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: HEPA filter loading and headspace aerosols.

Remarks: S2/E2 based on analyzed accident, Unfiltered Release.
F0 based on insufficient heat loading in tank waste to raise dome space temperature above ambient supernatant or service water temperature such that spray would cause a large pressure drop.
This hazardous condition derived from Project W-320 hazardous condition # W320-D-VENT04.
Exhauster would have to be down for a while to build up this much heat.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-G-05	Release of radioactive or hazardous materials from 241-C-106 to the surface through pits and risers due to backflow of waste from receiver tank	Siphon of waste from receiver tank to C-106 overfills tank with leak to ground	S2	F0	E2	33AX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 33.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.
F0 based on waste distributor drop leg above waste in headspace thus creating a vacuum break.
Engineering design show no changes such that new drop legs or slurry distributors are to be installed in the receiver tank
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure.*

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-H-01	Release of radioactive or hazardous material to atmosphere from 241-C-106 due to unplanned nuclear criticality	Sluicing selectively removes neutron poisons resulting in criticality, steam generation and ventilation system failure	S2	F0	E2	01X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 33.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: HEPA filter loading and fission gasses

Remarks: S2/E2 based on analyzed accident, Nuclear Criticality.
F0 based on calculations found in RPP-7475, Rev. 1, *Criticality Safety Evaluation of Hanford Tank Farms Facility*, that concludes that sluicing or transfer and storage of the waste in 241-C-106 will not create the possibility of a criticality. This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-H-02	Release of radioactive or hazardous materials from tank 241-C-106 due to flammable gas deflagration in dome space	High waste temperature during transfer causing a steam bump which induces a flammable gas release/ignition	S2	F1	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration.	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEP A filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems	RPP-13547, Rev. 0, *Evaluation of the Potential or Tank 241-C-JO6 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank heads pace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.

F1 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing coupled with a relatively low waste temperature documented in the process control plan (RPP-13707, Rev. 0, *Process Control Plan for Tank 241-C-106 Closure*, Rev. 0).

This hazardous condition derived from Project W-320 hazardous condition # W320-A-TRANS04.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure.*

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-H-03	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to flammable gas deflagration	Temperature out of specification causing a steam bump when level is lowered resulting in release/ignition of a flammable gas	S2	F1	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration.	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEP A filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems	RPP-13547, Rev. 0, *Evaluation of the Potential or Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.

F1 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing coupled with a relatively low waste temperature documented in the process control plan (RPP-13707, Rev. 0, *Process Control Plan for Tank 241-C-106 Closure* Rev. 0).

This hazardous condition derived from Project W-320 hazardous condition # W320-A-TRANS05.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-H-04	Release of radioactive or hazardous materials from tank 241-C-106 pit to the atmosphere due to spray leak from flammable gas deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in damage to transfer lines and spray release	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
Transfer Leak Detection Systems	X	--	Provide an alarm when waste is detected in transfer related structures to alert operators to take mitigative actions.	None

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.1.3 Transfer Leak Detection Systems	Ensures operability of the transfer leak detection system	None
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None
AC; 5.20 Transfer Pump Administrative Lock Controls	Reduces the possibility of waste leakage accumulating in waste transfer-associated structures thereby preventing flammable gas hazards from developing within the structures.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak.

F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.

This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS21.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-H-05	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to organic waste fire	Formation of organic layer in tank during sluicing and subsequent ignition of organics	S3	F0	E3	09X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 33.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols

Remarks: S3/E3 based on analyzed accident, Organic Solvent Fire.
F0 based on water sluicing combined with no indication of solvents remaining after initial sluicing.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-ALL10.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-H-06	Release of radioactive or hazardous materials from tank 24I-C-106 to atmosphere due to organic waste fire	Loss of ventilation for many months, dry out of waste and subsequent ignition of organics	S3	F0	E3	09X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 33.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols

Remarks: S3/E3 based on analyzed accident, Organic Solvent Fire.
F0 based on water sluicing combined with no indication of large amounts of solvents remaining after initial sluicing.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-VENT08.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-H-07	Release of ammonia gas from tank to atmosphere due to burp which exposes facility personnel to hazardous gases	Sluicing causes release of ammonia	S1	F3	E1	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No safety SSCs or TSRs required - Facility worker risk controlled by TFC Safety Management Programs (Industrial Health and Safety).

Revision to Original HAZOP: None

Material At Risk: Ammonia

Remarks: S1/E1 based on limited amount of waste in tank.
F3 based on anticipated release of ammonia.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-TERM01.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-H-08	Release of radioactive liquid waste from tank 241-C-106 to soil subsurface due to large water intrusion	Large water intrusion resulting in high hydrostatic pressure and tank breach (Service water, surface flood, excessive transfer, or cascade)	S0	F3	E2	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No Safety SSCs or TSRs - Hazardous Conditions with significant environmental impact but low safety consequence (S0/S1) are addressed by Environmental Controls specified in Tank Farms FSAR Section 3.3.2.3.4, Environmental Protection (Table 3.3.2.3.4-1).

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S0 based on no worker exposure.
E2 based on leak of tank waste to soil column.
F3 based on unlimited water available trough sluicing system hookup to service water supply system.
This hazardous condition derived from Project W-320 hazardous condition # W320-B-ALL11.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-1-01	Release of radioactive or hazardous material from damaged 241-AY-102 ventilation system due to mixing of incompatible material	Transferred waste reacts with waste in tank causing steam or gas generation which pressurizes the tank causing failure of the HEPA filters	S2	F0	E2	03X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: HEPA filter loading and tank headspace loading

Remarks: S2\E2 based on analyzed accident, Mixing of Incompatible Materials-Tank Pressurization.
F0 based on letter reports 74100-98-019, Interoffice Memo from DST Engineering to P.G. O'Connor, *Waste Compatibility Assessment of Tank 241-C-106 Waste (ETF-98-02) with Tank 241-AY-102 Waste*, and 74100-99-028, Interoffice Memo from T.M. Blaak to J. J. Sutey, *Waste Compatibility Assessment of Tank 241-C-106 Waste (SST-9907 with Tank 241-AY-102 Waste*, concluding that sluiced waste from 241-C-106 will be compatible with any waste in the DST receiver tank.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-1-02	Large release of radioactive or hazardous materials from receiver DST to the atmosphere due to flammable gas deflagration	Influx of cold water spray into tank causing excessive vacuum with a large flammable gas release as a result of waste transfer; gas is ignited	S3	F0	E3	04X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S3/E3 based on analyzed accident, Flammable Gas Deflagration.
F0 based on the process control plan (PP-13707, Rev. 0, *Process Control Plan for Tank 241-C-106 Closure)* and tank temperature profiles from the *Tank Waste Information Network System* (TWINS) database that there is not enough difference between transferred waste temperature and tank headspace temperature to create sufficient vacuum to induce a large gas release event.
This hazardous condition derived from Project W-320 hazardous condition # W320-D-VENT13.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-I-03	Release of radioactive or hazardous materials from tank 241-AY -102 to atmosphere due to flammable gas deflagration	Pumping of more solids than anticipated, annulus cooling not adequate, waste is overheated causing a tank bump that results in a gas release event with ignition	S3	F0	E3	04X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S3/E3 based on analyzed accident, Flammable Gas Deflagration.
F0 based on the small amount of sludge being transferred (23 kL) from 241-C-106 compared to the amount present in 241-AY-102 (548 kL) as listed in Appendix F of RPP-13557. The isotopic breakdown of the solids is similar (Appendix A of RPP-13557) thus the four percent increase in that the heat loading caused by transfer of the remaining waste in 241-C-106 is, in and of itself, insufficient to induce a gas release event.
This hazardous condition derived from Project W-320 hazardous condition # W320-D-PUMP04.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-I-04	Release of liquid waste into annulus of receiver DST due to tank equipment penetrating tank liner	Distributor/dropleg breaks off dropping into tank and penetrates tank liner resulting in leakage to annulus	S0	F0	E0	--

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S0 based on no worker exposure.
E0 based on no release to environment.
F0 based on consensus of HAZOP team that slurry distributor/drop leg is not massive enough to penetrate tank bottom.
This hazardous condition derived from Project W-320 hazardous condition # W320-ABCD-TRANS04.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-I-05	Release of toxic material from tank 241-AY – 102 to the atmosphere due to mixing of incompatible material	Waste transfer reacts with waste in tank resulting in the release of toxic gasses	S2	F0	E2	23X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
None	--	--

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: No controls required for F0 event. Controls are not required as established by the Risk Matrix, Table 3.3.1.5-2 in the FSAR. By established convention, the related field in the Hazard Analysis Database is left blank.

Revision to Original HAZOP: None

Material At Risk: Toxic gasses

Remarks: S2/E2 based on analyzed accident, Mixing of Incompatible Material, Toxic Vapor Generation.
F0 based on letter reports 74100-98-019, Interoffice Memo from DST Engineering to P.G. O'Connor, *Waste Compatibility Assessment of Tank 241-C-106 Waste (ETF-98-02) with Tank 241-AY-102 Waste*, and 74100-99-028, Interoffice Memo from T.M. Blaak to J. J. Sutey, *Waste Compatibility Assessment of Tank 241-C-106 Waste (SST-9907 with Tank 241-AY-102 Waste*, concluding that sluiced waste from 241-C-106 will be compatible with any waste in the DST receiver tank.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-I-06	Release of radioactive or hazardous material from receiver tank to the ground surface due to overfilling	Unlimited sluicing and waste transfer overfills receiver tank with overflow through pit to ground	S2	F3	E2	33X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC; 5.24 Safety Management Programs (Radiation Protection)	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	--	--

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak

F3 based on unlimited amount of sluice water from Hanford service water lines.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-l-07	Release of radioactive or hazardous material from receiver tank to the ground surface due to overfilling	Line flush overfills receiver tank with overflow through pit to ground	S2	F3	E2	33CX

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.12 Waste Transfer Controls (Operating Requirements, Material Balance)	Requires periodic material balances to provide a means to detect transfer line leaks or misroutes, allowing workers to take mitigative actions.	None
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a waste transfer leak (i.e., pool on or near the surface) by moving workers away.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that instruments used to perform material balance tank level monitoring, or service water monitoring are calibrated.	None
AC 5.21 Tank Service Water Intrusion Monitoring Program	Mitigates facility worker and onsite worker consequences due to in-tank waste leaks.	Radiation protection practices detect contamination on the soil or in structures.

Preventive TSR		
Control	Safety Function	Comments
None	Prevents tank overflow from service water leaks.	None

Control Memo: Controls based on analyzed accident, Waste Transfer Leak.

Revision to Original HAZOP: None

Material At Risk: Tank waste

Remarks: S2/E2 based on analyzed accident, Waste Transfer Leak

F3 based on unlimited amount of sluice water from Hanford service water lines.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-J-01	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	In-tank instrumentation fails causing a spark which ignites flammable gas causing damage to the ventilation system	S2	F2	E2	05X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
SST Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration.	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEP A filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.2.3 SST Ventilation Systems-Passive	Ensures operability of the passive ventilation systems	RPP-13547, Rev. 0, *Evaluation of the Potential or Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* concluding that the waste volume in 241-C-1O6 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.11 Flammable Gas Monitoring Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.

F2 based on the analysis documented in RPP-13547, Rev. 0, *Evaluation of the Potential for Tank 241-C-106 to Achieve a Flammable Gas Atmosphere* that concluded that the waste volume in 241-C-106 is insufficient to generate sufficient gas to reach lower flammability limit with barometric breathing.

This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

Control Decision Record

Activity Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure

ID	Hazardous Condition	Cause	Cons Cat	Freq Cat	Env Cons	Rep Acc
C106PHASE 1-J-02	Release of radioactive or hazardous material from 241-AY-102 to the atmosphere due to a flammable gas deflagration	In-tank instrumentation fails causing a spark which ignites flammable gas causing damage to the ventilation system	S2	F3	E2	04X

Structures, Systems, and Components (SSCs)

Mitigative SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
None	--	--	--	--

Preventive SSCs				
SSC	Classification		Safety Function	Comments
	SS	SC		
DST and A WF Primary Tank Ventilation Systems	--	X	Prevents the accumulation of flammable gas due to steady state accumulation, thus reducing the frequency of a flammable gas deflagration.	None

Technical Safety Requirements (TSRs)

Mitigative TSR		
Control	Safety Function.	Comments
AC; 5.14 Emergency Preparedness (Response Procedures)	Mitigates the consequence of a flammable gas deflagration.	None
AC; 5.18 HEPA Filter Controls	Reduces the consequences of a HEP A filter failure by limiting the inventory available.	None

Preventive TSR		
Control	Safety Function	Comments
LCO; 3.2.1 DST and A WF Ventilation Systems	Ensures operability of the active ventilation systems.	None
AC; 5.9 Flammability Controls	Assures flammable gas hazards are managed.	None
AC; 5.10 Ignition Controls	Reduces frequency of flammable gas deflagrations.	None
AC; 5.12 Transfer Controls	Ensures that the final tank states remain within the analyzed topography of the flammable gas deflagrations accident.	None
AC; 5.19 Process Instrumentation and Measuring and Test Equipment	Ensures that equipment used to verify process parameters specified in the TSR is maintained.	None

Control Memo: Controls based on SB, FSAR Appendix K.

Revision to Original HAZOP: None

Material At Risk: Tank headspace aerosols and HEPA filter loading.

Remarks: S2/E2 based on analyzed accident, Flammable Gas Deflagration.
F3 based on analyzed accident, Flammable Gas Deflagration in DST.
This hazardous condition evaluated in RPP-13557, Rev. 0, *Safety Evaluation of Phase 1 Retrieval of 241-C-106 for Closure*.

APPENDIX E

HAZARD EVALUATION TABLES

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Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
Node A: Equipment Installation and Decommissioning										
A-01	Release of radioactive or hazardous material from unfiltered release paths and damaged ventilation system to the atmosphere due to a flammable gas deflagration	Removal of in tank equipment (e.g., heel jet pump) causes spark and ignites flammable gas	Waste release to atmosphere from damaged ventilation system	SST Passive Vent. System	LCO Vent system Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL Passive ventilation will be used during this activity
A-02	Release of radioactive or hazardous material from unfiltered release paths and damaged ventilation system to the atmosphere due to a flammable gas deflagration	Installation of new equipment (e.g., transfer pump) causes spark and ignites flammable gas	Waste release to atmosphere from damaged ventilation system	SST Passive Vent. System	LCO Vent system Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL Passive ventilation will be used during this activity
A-03	Release of radioactive or hazardous material from damaged HEPA filter to atmosphere due to high temperature	Vehicle strikes object rupturing the fuel tank causing fire near the 241-C-106 passive ventilation system damaging the HEPA filter	Release of radioactive material to atmosphere from damaged HEPA filter	HEPA Filters	HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S2	F3	E2	06X	S2/E2 conservatively based on analyzed accident HEPA filter failure-exposure to high temperature or pressure for active ventilation system. This would be S1/E1 for a passively ventilated system. F3 based on anticipated vehicle accident in the tank farm. Installation activities will rely on passive ventilation. Decommissioning may have active ventilation systems

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
A-04	Release of radioactive or hazardous material from damaged HEPA filter to atmosphere due to high temperature	Vehicle strikes object rupturing the fuel tank causing fire near the 241-C-106 active ventilation system damaging the HEPA filter	Release of radioactive material to atmosphere from damaged HEPA filter	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S2	F3	E2	06X	S2/E2 conservatively based on analyzed accident HEPA filter failure-exposure to high temperature or pressure for active ventilation system. This would be S1/E1 for a passively ventilated system. F3 based on anticipated vehicle accident in the tank farm. Installation activities will rely on passive ventilation. Decommissioning may have active ventilation systems
A-05	Release of radioactive or hazardous material from damaged HEPA filter to atmosphere due to high temperature	Vehicle strikes object rupturing the fuel tank causing fire near the slurry receiver DST ventilation system damaging the HEPA filter	Release of radioactive material to atmosphere from damaged HEPA filter	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S2	F3	E2	06X	S2/E2 conservatively based on analyzed accident HEPA filter failure-exposure to high temperature or pressure for active ventilation system. This would be S1/E1 for a passively ventilated system. F3 based on anticipated vehicle accident in the tank farm. Installation activities will rely on passive ventilation. Decommissioning may have active ventilation systems
A-06	Release of radioactive or hazardous material from a pit to the atmosphere due to a fire	Vehicle strikes pit rupturing the fuel tank which drains into a pit and ignites	Release of contamination from the pit to the atmosphere	Traffic Barriers	Ignition (Vehicle Controls) Emergency Preparedness (Response Procedures)	S2	F3	E2	07X	S2/E2 based on analyzed accident, fire in contaminated area F3 based on anticipated vehicle accident in tank farms

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
A-07	Release of radioactive or hazardous materials from pit to the atmosphere due to high winds	High winds/dust devil during plug removal from pit cover or pit cover removal or equipment installation or removals	Waste release to atmosphere	Environmental barrier	Radiation Protection Program	S1	F3	E1	—	S1/E1 based on analyzed accident, natural phenomena-high wind F3 based on anticipated high winds Environmental barrier is open on top. Contamination will be fixed either before cover block removal or as soon as possible afterwards. Temporary covers can be quickly installed if a dust devil is spotted or winds pick up. Training covers these eventualities. Active ventilation may be required for work in the 241-C-106 pump pit due to high contamination levels. This hazardous condition derived from Project W-320 hazardous condition # W320-B-ALL14
A-08	Release of radioactive or hazardous material from unfiltered release paths through damaged tank dome due to excessive loads	Worker error positions crane over 241-C-106 when lifting cover blocks or installing other on tank equipment (e.g., water skid) causing damage to the tank dome	Waste Release to atmosphere	None	Load Lifting and Dome Loading Controls Mechanical Lifts within 20 Ft Hoisting and Rigging Manuel Dome Loading Program Radiation Protection Program	S1	F3	E1	—	S1/E1 based on limited release of tank headspace aerosols through cracks in dome filtered through soil cover. F3 based on anticipated load drop

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
A-09	Release of radioactive or hazardous material from unfiltered release paths through damaged tank dome due to excessive loads	Worker error causes too much lifting force when removing stuck heel jet pump in 241-C-106 heel pit with resultant riser damage	Waste Release to atmosphere	Crane Scale	Load Lifting and Dome Loading Controls Mechanical Lifts within 20 Ft Hoisting and Rigging Manuel Dome Loading Program Radiation Protection Program	S1	F3	E1	—	S1/E1 based on limited release of tank headspace aerosols through cracks in dome filtered through soil cover. F3 based on anticipated load drop To avoid this issue, an "A" frame or hydraulic jacks will be used to have better load control until the pump is broken loose.
A-10	Serious injury or fatality due to overloaded crane and boom failure	Worker error cause too much lifting force when removing equipment causing crane or rigging failure	Serious worker injury or fatality	Crane Scale	Load Lifting and Dome Loading Controls Mechanical Lifts within 20 Ft Hoisting and Rigging Manuel Dome Loading Program Worker Protection Program	S1	F3	E0	—	S1 based on injury to facility worker only E0 based on no environmental release F3 based on anticipated load lifting accident
A-11	Release of radioactive or hazardous material to the atmosphere due to an unfiltered release	Improperly assembled or damaged ventilation system causes unfiltered release path around HEPA filter	Waste Release to atmosphere	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S1	F3	E1	—	S1/E1 based on limited release from small leaks in ventilation system F3 based on anticipated worker error

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
A-12	Release of radioactive or hazardous material from the 241-C-106 heel jet pump to the ground due to a leak in the flexible receiver, or other containment device	Waste trapped in heel jet pump is released from the flexible receiver when it is lifted from the tank causing a waste leak to the ground surface	Waste release to ground surface	None	Radiation Protection Program	S1	F3	E1	—	S1/E1 based on limited volume of waste contained in pump that could spill F3 based on process knowledge and tank farms operating history showing waste collection in pumps and other hollow tank equipment Process knowledge for tank 241-C-106 indicates that there may be over 6 feet of sludge or liquid trapped in the heel jet.
Node B: Process Water Supply System, including Flush systems for Slurry Transfer Lines										
B-01	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere through breached filters due to ignition of flammable gas	GRE induced by large water intrusion (misroute) into tank with ignition of flammable gas and resulting filter breach	Waste release to atmosphere	Tank Level Detection System Service Water Flow Totalizer Leak Detection Systems	Tank Service Water Intrusion Monitoring Program Ignition Source Controls Flammable Gas Monitoring Controls	S2	F2	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL This hazardous condition derived from Project W-320 hazardous condition # W320-B-FLUSH01
B-02	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere from unfiltered pathways due to tank failure due to excessive loads	Leak of service water saturates soil above tank 241-C-106 causing tank overload and dome cracking	Waste Release to atmosphere	None	Emergency Preparedness (Response Procedures) Radiation Protection Program	S1	F0	E1	—	S1/E1 based on limited release of tank headspace aerosols through cracked dome F0 based on analyzed accident showing water loading in soil cover is insufficient to damage dome

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
B-03	Release of liquid waste from tank 241-C-106 to soil subsurface due to service water leak in sluice pit	Large water intrusion resulting in high liquid level in tank and primary liner rupture	Below grade radioactive liquid and hazardous liquid release	Tank Level Detection System Service Water Flow Totalizer Leak Detection Systems	Tank Service Water Intrusion Monitoring Program	S0	F3	E2	—	S0 based on no worker exposure E2 consistent with small amount of waste in tank F3 based on based on unknown condition of waste tank above last beach line
B-04	Release of radioactive liquid from tank 241-C-106 to tank 241-C-105 due to large water intrusion	Intrusion of water into tank 241-C-105 from tank 241-C-106 due to cascade effect	Undesired tank condition in tank 241-C-105	Tank Level Detection System Service Water Flow Totalizer Leak Detection Systems	Tank Service Water Intrusion Monitoring Program	S0	F1	E0	—	S0 based on no worker exposure E0 based on no release to environment F1 based on HAZOP team consensus that a water intrusion of over 500,000 gal. to reach the cascade was beyond extremely unlikely This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL09 241-C-105 is listed as a sound tank.
B-05	Release of radioactive or hazardous materials from service water system to atmosphere due to spray leak from starting supernatant transfer pump in tank 241-C-106 during the flush of transfer line	Supernatant transfer pump in tank 241-C-106 is started during the flush of transfer line and flush line is filled and pressurized resulting in flush line leak or backflow into service water system	Aerosolized radioactive waste release to atmosphere	Pressure Switch Interlock or Alarm (Service Water Lines) Backflow Prevention System	LCO Service Water Pressure Detection System LCO Backflow Prevention System Transfer Controls (Configuration Management) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Trans Pump Administrative Lock Controls	S2	F3	E2	33DX	S2/E2 based on analyzed accident, waste transfer leak F3 based on anticipated worker error This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-FLUSH02*

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
B-06	Release of radioactive or hazardous materials from service water system to atmosphere due to spray leak from a backflow of tank waste into the service water system	Valve alignment is incorrect or leaking valves cause waste from the supernatant transfer pump in tank 241-C-106 to backflow into service water system resulting in waste leak	Aerosolized radioactive waste release to atmosphere	Pressure Switch Interlock or Alarm (Service Water Lines) Backflow Prevention System	LCO Service Water Pressure Detection System LCO Backflow Prevention System Transfer Controls (Configuration Management) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Trans Pump Administrative Lock Controls	S2	F3	E2	33DX	S2/E2 based on analyzed accident, waste transfer leak F3 based on anticipated worker error This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-FLUSH02*
B-07	Release of radioactive liquid from tank 241-C-106 to the soil surface due to tank overflow	Large water intrusion (Service water, surface flood, cascade) or excessive transfer causing overflow of tank	Radioactive liquid and hazardous liquid release to surface	Transfer Leak Detection System Pressure Switch Tank Level Detection System Service Water Flow Totalizer	LCO Trans. Leak Detection System Transfer Controls (Tank Levels) Emergency Preparedness (Emergency Response) Process Instrumentation and Measuring and Test Equipment Tank Service Water Intrusion Monitoring Program Safety Management Programs	S2	F1	E2	33CX	S2/E2 based on analyzed accident, waste transfer leak F1 based on HAZOP team consensus that a water intrusion or misroute of over 500,000 gal to reach the cascade was beyond extremely unlikely This hazardous condition derived from Project W-320 hazardous condition # W320-ABCD-ALL07

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
B-08	Release of radioactive or hazardous waste from the sluice or pump pit on 241-C-106 to the atmosphere due to hydraulic fluid fire in the pit	Rupture of a hydraulic line to the sluicing articulation actuators leaks into the 241-C-106 sluice or pump pit and is ignited releasing contamination in the pit	Release of contamination from the 241-C-106 heel pit	None	Use of nonflammable hydraulic fluids	S2	F2	E2	07X	S2/E2 based on analyzed accident, fire in contaminated area F2 based on difficulty of igniting hydraulic fluid when no normal heat source is present in the pit The HAZOP team discounted ignition of hydraulic fluid in the tank due to the presence of large amounts of water relative to the amount of hydraulic fluid that could leak to the tank. If hydraulic drive is chosen for slurry pump, Shell Tellus 46 hydraulic fluid will be used which prevents ignition
B-09	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to flammable gas deflagration	A hot spot or spark from the supernatant transfer pump ignites flammable gas released during sluicing causing failure of the ventilation system and continued unfiltered release	Release of tank waste to atmosphere	SST Active Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
Node C: Sluicing System										
C-01	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to tank dome breach from impact	During sluicing operations sluicer moves debris in waste impacting drop leg or in tank equipment which breaches dome causing unfiltered release (assumes ventilation system failure)	Waste release to atmosphere	None	Radiation Protection Program	S1	F1	E1	—	S1/E1 based on limited amount of material that could be released through small crack or breach in dome F1 based on drop legs being high in head space such that any debris that could be moved that far would be very small and light and extremely unlikely to cause any damage This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS03
C-02	Release of radioactive or hazardous material from 241-C-106 to the soil column due to tank liner breach	Mechanical failure causes sluicer to fall puncturing tank bottom	Release of tank waste to soil column	None	Environmental Compliance Controls	S0	F1	E2	—	S0 based on depth of release which will not affect workers E2 based on release of tank waste to soil column F1 based on having to completely fail large metal structure. See Environmental Controls in Tank Farms FSAR Chapter 3, paragraph 3.3.2.3.4, Environmental Compliance Program (Table 3.3.2.3.4-1)

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
C-03	Release of radioactive or hazardous material from 241-C-106 to the soil column due to tank liner breach	Sluice jet impinges on weak section of tank wall causing minor leak of water or tank waste behind liner and subsequent leak to soil column	Release of tank waste to soil column	None	Environmental Compliance Controls Pressure limitations	S0	F2	E2	—	S0 based on depth of release which will not affect workers E2 based on release of tank waste to soil column F2 based on tank being at the end of design life See Environmental Controls in Tank Farms FSAR Chapter 3, paragraph 3.3.2.3.4, Environmental Compliance Program (Table 3.3.2.3.4-1)
C-04	Release of radioactive or hazardous material from 241-C-106 to the soil column due to tank liner breach	Sluice jet impinges on flashing causing minor leak of water or tank waste behind liner and subsequent leak to soil column	Release of tank waste to soil column	Sluice index limiter	Environmental Compliance Controls	S0	F3	E2	—	S0 based on depth of release which will not affect workers E2 based on release of tank waste to soil column F3 based on tank on tank design where the lead flashing does not provide a seal when a jet of liquid impinges directly on the underside. See Environmental Controls in Tank Farms FSAR Chapter 3, paragraph 3.3.2.3.4, Environmental Compliance Program (Table 3.3.2.3.4-1) Sluicer design limits sluice nozzle from reaching horizontal

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
C-05	Transfer of contaminated sluice water to 241-C-105 due to backflow of sluice water through cascade line	Sluice jet impinges on cascade line causing water to backflow to 241-C-105	Addition of waste into 241-C-105	Sluice index mechanism	Sluicing controls	S0	F3	E0	—	S0 based on no release to surface and no dose to workers E0 based on no release of waste as 241-C-105 is considered to be a sound tank F3 based on cascade line being open and accessible by the jet with no indexing limiter This hazard would cause a program delay because of the prohibition of adding waste to a SST.
C-06	Release of ionizing radiation and radioactive gas from tank 241-C-106 to the atmosphere due to criticality in the tank	Excessive solids in slurry flow towards supernatant transfer pump	Release of radioactive gasses and direct radiation (neutrons)	None	Nuclear Criticality Safety	S2	F0	E2	01X	S2/E2 based on analyzed accident, nuclear criticality F0 based on consensus of HAZOP team that retrieval or storage of 241-C-106 waste could not create a criticality This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-TRANS02b
C-07	Release of ionizing radiation and radioactive gas from tank 241-C-106 to the atmosphere due to criticality in the tank	Material reaches critical mass/formation during sluicing activities	Release of radioactive gasses and direct radiation (neutrons)	None	Nuclear Criticality Safety	S2	F0	E2	01X	S2/E2 based on analyzed accident, nuclear criticality F0 based on consensus of HAZOP team that retrieval or storage of 241-C-106 waste could not create a criticality This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-TRANS04

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
C-08	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to flammable gas deflagration	The sluicer impinging into the solids releasing a region of retained flammable gas which is then ignited	Waste release to atmosphere	SST Active Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system LCO Primary Tank Leak Det. Sys Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness (Emergency Response) Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS17
C-09	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	Sluicing nozzle strikes object when being indexed causing spark and ignition of flammable gas with damage to the ventilation system	Release of headspace aerosols and HEPA loading to atmosphere	SST Active Vent. System Sluicer motion limiters	LCO Vent Stack Cam Interlock System LCO Vent system Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness (Emergency Response) Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, Flammable Gas Deflagrations F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL Sluicer position in tank precludes striking tank walls, floor, or in-tank equipment.
C-10	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	Sluice jet moves debris causing spark and flammable gas ignition with damage to the ventilation system	Release of headspace aerosols and HEPA loading to atmosphere	SST Active Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness (Emergency Response) Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, Flammable Gas Deflagrations F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
C-11	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable gas deflagration	Hydraulic reaction force of jet bends sluicing mechanism against riser causing friction when indexing and ignition of flammable gas with damage to the ventilation system	Release of headspace aerosols and HEPA loading to atmosphere	SST Active Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness (Emergency Response) Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, Flammable Gas Deflagrations F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL
C-12	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to vacuum induced tank damage	Water spray through sluice nozzle cools tank headspace resulting in excessive tank vacuum damaging tank	Release of radioactive or hazardous materials through an unfiltered pathway	None	Safety Management Programs Emergency Preparedness (Emergency Response)	S2	F1	E2	13X	S2/E2 based on limited amount of material that remains in tank that could be released via a major tank structural failure F1 based on based on analyzed accident that found this type of failure to be extremely unlikely This hazardous condition derived from Project W-320 hazardous condition # W320-B-FLUSH04 Accident analysis specifies structural failure due to excessive pressure (vacuum) is not credible.

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
C-13	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to vacuum induced tank damage	Water spray through anti-siphon holes causes rapid cooling of the headspace resulting in excessive tank vacuum and tank breach	Aerosolized radioactive waste release to atmosphere	None	Safety Management Programs Emergency Preparedness (Emergency Response)	S2	F1	E2	13X	S2/E2 based on limited amount of material that remains in tank that could be released via a major tank structural failure F1 based on analyzed accident that found this type of failure to be extremely unlikely This hazardous condition derived from Project W-320 hazardous condition # W320-B-FLUSH05
C-14	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to a steam bump	Sluicing reduces the confinement over a hot spot in the sludge where the temperature has reached saturation causing a localized steam eruption	Waste release to atmosphere	SST active ventilation system	LCO SST active ventilation system	S1	F0	E1	—	S1/E1 based on limited release from small, localized steam release F0 based on insufficient waste in tank to develop localized saturated conditions
C-15	Release of liquid waste from tank 241-C-106 to the soil and aerosol release to the atmosphere due to steam bump in liner gap	High pressure sluice induces movement of debris present in waste which impact and breaches the tank liner resulting in water leakage into liner gap, steam formation and bump breaching tank bottom	Below grade radioactive liquid and hazardous liquid release; large steam bump aerosol release to atmosphere	Temperature Monitoring System SST Active Ventilation System	Process Instrumentation, Measuring, and Test Equipment	S2	F0	E2	18AX	S2/E2 based on analyzed accident, steam bump F0 based on insufficient waste in tank to develop saturated conditions between liner and waste This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS09

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
C-16	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere through failed filters due to condensation of vapor in head space	Condensation of vapor in head space of tank 241-C-106 which resulted from the breaking off of sluicer head causes large pressure drop in the dome space (sluicer failure, water hammer, thermal shock, corrosion or fatigue) causing reverse airflow and HEPA filter failure	Waste release to atmosphere	None	Safety Management Programs Emergency Preparedness	S2	F0	E2	18BX	S2/E2 based on analyzed accident, unfiltered release F0 based on insufficient heat loading in tank waste to raise dome space temperature above ambient service water temperature such that spray would cause a large pressure drop This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS03
C-17	Release of radioactive or hazardous materials from tank 241-C-106 sluice pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	Aerosolized radioactive liquid release to pit with small leakage to atmosphere	Pipe Encasements Transfer Leak Detection System Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Configuration Management) Transfer Controls (Material Balance) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Transfer System Cover Removal Program Safety Management Programs	S2	F3	E2	33CX	S2/E2 based on analyzed accident F3 based on anticipated jumper or connection leak This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS31

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
C-18	Release of radioactive or hazardous materials from tank 241-C-106 sluice pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	Aerosolized radioactive waste release to atmosphere	Pipe Encasements Transfer Leak Detection System Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Configuration Management) Transfer Controls (Material Balance) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Transfer System Cover Removal Program Safety Management Programs	S2	F3	E2	33CX	S2/E2 based on analyzed accident F3 based on anticipated jumper or connection leak This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS25
C-19	Release of radioactive or hazardous material from 241-C-106 from pits and risers to the ground surface due to overfilling the tank with sluice water	Sluicing with service water for long period of time or during back flush with no or insufficient pumping causes tank overflow	Tank waste leak to ground surface	Transfer Leak Detection System	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Tank Levels) Emergency Preparedness (Response Procedures) Process Instrumentation and Measuring and Test Equipment Tank Service Water Intrusion Monitoring Program Safety Management Programs (Radiation Protection)	S2	F2	E2	33CX	S2/E2 based on analyzed accident, waste transfer leak F2 based on having to mistransfer over 600,000 gal of sluice water before overflowing the tank without taking credit for backflow to 241-C-105, 106 tanks through the cascade lines
C-20	Release of radioactive or hazardous material from 241-C-106 to the atmosphere from unfiltered release paths due to a tank pressurization	Sluice water evaporates in relatively dry headspace causing a momentary positive spike in headspace pressure releasing headspace contaminates through unfiltered leak paths	Headspace aerosol release through unfiltered paths	None	Safety Management Programs (Radiation Protection	S1	F3	E1	—	S1/E1 based on limited release due to the brief period of positive pressure and release. F3 based on process knowledge from this condition happening during project W-320 sluicing of tank 241-C-106.
Node D: Slurry Transfer Pump										

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
D-01	Worker exposed to ionizing radiation when replacing a damaged transfer pump	Debris (e.g., tape) damages supernatant transfer pump which must be replaced causing unplanned dose to workers	Worker exposure to ionizing radiation	Shielding	Radiation Protection Program	S1	F3	E0	—	S1 based on worker exposure only. E0 based on no release to environment F3 based on anticipated equipment failure
D-02	Worker exposed to ionizing radiation when replacing a damaged transfer pump	Electric motor hooked up backwards driving pump in reverse damages pump which must be replaced causing unplanned dose to workers	Worker exposure to ionizing radiation	Shielding Reverse rotation preventer Special fittings on pump	Radiation Protection Program	S1	F3	E0	—	S1 based on worker exposure only. E0 based on no release to environment F3 based on anticipated equipment failure
D-03	Release of ionizing radiation and radioactive gas from tank 241-C-106 to the atmosphere due to criticality in the tank pump vortices	Accumulation of material in the pump vortices until critical mass condition are met	Radioactive gas release through ventilation system and worker exposure to high energy neutron radiation	Pump Involute Flush System	Nuclear Criticality Safety	S2	F0	E2	01X	S2/E2 based on analyzed accident, nuclear criticality F0 based on consensus of HAZOP team that retrieval or storage of 241-C-106 waste could not create a criticality This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-TRANS01
D-04	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to flammable gas deflagration	A hot spot or spark from supernatant transfer pump ignites flammable gas released during sluicing causing failure of the ventilation system and continued unfiltered release	Release of tank waste to atmosphere	SST Active Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
D-05	Release of radioactive or hazardous material from tank 241-C-106 to the atmosphere due to HEPA filter failure caused by high pressure	A leak in the supernatant transfer pump caused by a failed component or mis-assembly causes excessive aerosols which plug the HEPA causing failure by high differential pressure	Release of tank waste to the atmosphere	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S2	F3	E2	06X	S2/E2 conservatively based on analyzed accident HEPA filter failure-exposure to high temperature or pressure for active ventilation system. This would be S1/E1 for a passively ventilated system. F3 based on aerosol generation and filter loading during sluicing
D-06	Release of radioactive or hazardous waste from the sluice pit on 241-C-106 to the atmosphere due to hydraulic fluid fire in the pit	Rupture of a hydraulic line to the sluice nozzle indexer leaks into the 241-C-106 sluice pit and is ignited releasing contamination in the pit	Release of contamination from the 241-C-106 sluice pit	None	Use of nonflammable hydraulic fluids	S2	F2	E2	07X	S2/E2 based on analyzed accident, fire in contaminated area F2 based on difficulty of igniting hydraulic fluid when no normal heat source is present in the pit The HAZOP team discounted ignition of hydraulic fluid in the tank due to the presence of large amounts of water relative to the amount of hydraulic fluid that could leak to the tank. If hydraulic drive is chosen for slurry pump, Shell Tellus 46 hydraulic fluid will be used which prevents ignition

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
D-07	Release of radioactive liquid from the receiver tank to soil subsurface due to over filling	Continued sluicing and pumping from tank 241-C-106 resulting in over flow of receiver tank and above ground leak of tank waste	Abovegrade radioactive liquid and hazardous liquid release; possible aerosol release path to atmosphere	Transfer Leak Detection System Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Material Balance, Ground Radiation Survey) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Safety Management Programs	S2	F3	E2	33CX	S2/E2 based on analyzed accident, waste transfer leak F3 based on unlimited amount of sluice water from Hanford service water system This hazardous condition derived from Project W-320 hazardous condition # W320-B-ALL12
D-08	Release of radioactive or hazardous materials from tank 241-C-106 pump pit due to spray leak from jumper or pipe breach, cover block in place	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block in place	Aerosolized radioactive liquid release to pit with small leakage to atmosphere	Pipe Encasements Transfer Leak Detection System Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Configuration Management) Transfer Controls (Material Balance) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Transfer System Cover Removal Program Safety Management Programs	S2	F3	E2	33CX	S2/E2 based on analyzed accident, waste transfer leak F3 based on anticipated jumper or connection leak This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS30

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
D-09	Release of radioactive or hazardous materials from tank 241-C-106 pump pit to atmosphere due to spray leak from pipe or jumper breach with cover block off	Pipe/connector fault or improper assembly causes pipe or jumper breach with cover block off	Aerosolized radioactive waste release to atmosphere	Pipe Encasements Transfer Leak Detection System Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Configuration Management) Transfer Controls (Material Balance) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Transfer System Cover Removal Program Safety Management Programs	S2	F3	E2	33CX	S2/E2 based on analyzed accident F3 based on anticipated jumper or connection leak This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS24
D-10	Release of radioactive or hazardous material from the service water lines to the surface due to a backflow of waste	Leaking valves or incorrect valve alignment causes backflow of waste into service water line during transfer pump operation with leak through unmonitored service water system	Leak of tank waste to the surface	Pressure Switch Interlock or Alarm (Service Water Lines) Isolation Valves Backflow Prevention System	LCO Service Water Pressure Detection System LCO Backflow Prevention System Transfer Controls (Configuration Management) Transfer Controls (Material Balance) Transfer Controls (Tank Levels) Transfer Controls (Ground Radiation Survey) Emergency Preparedness (Response Procedures) Process Instrumentation and Measuring and Test Equipment Safety Management Programs	S2	F3	E2	33DX	S2/E2 based on analyzed accident, waste transfer leaks F3 based on sluice water system design taking no credit for backflow preventer Water pump has higher head thank slurry pump, however slurry pump is higher pressure than water line pressure without booster pump.

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
D-11	Release of radioactive or hazardous materials from tank 241-C-106 pump pit to atmosphere due to waste leak through the electrical connections into an electrical junction box	Electrical connector seal fault or improper assembly causes a flow of waste through the electrical cable up to the nearest junction box	Leak of tank waste to the surface	Transfer Leak Detection System Master Pump Shutdown System	Transfer Controls (Ground Radiation Survey) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Transfer System Cover Removal Program Safety Management Programs	S1	F3	E1	—	S1/E1 based on limited amount of waste that could flow up an electrical power cable F3 based on operational experience during pump run in testing
Node E: Transfer Line, 241-C-106 to 241-AY-102										
E-01	Personnel exposure to ionizing radiation due to excavation or construction activities uncovering shielding on hose-in-hose transfer lines	Error causes removal of shielding above hose-in-hose transfer line resulting in worker exposure to ionizing radiation	Unplanned exposure to ionizing radiation	None	Job hazard analysis Engineering procedures	S1	F3	E0	—	S1 based on worker exposure only E0 based on no releases F3 based on anticipated worker error, either in the field or office This hazardous condition derived from Project W-320 hazardous condition # W320-ABCD-TRANS16
E-02	Release of radioactive or hazardous material from a ruptured transfer hose to the atmosphere due to high compressed air pressure	Compressed air blowdown ruptures transfer line with release to atmosphere	Release of tank waste to the atmosphere	Hose-in-hose encasement Transfer Leak detection System Over-pressure relief valve	LCO Trans. Leak Detection System Emergency Preparedness (Response Procedures) Safety Management Program	S1	F2	E1	—	S1/E1 based on compressed air line rupture analysis F2 based on factor of safety of hose relative to rated pressure of portable compressors normally used in tank farms
E-03	Worker exposure to ionizing radiation due to back flow of waste into compressed air system	Radioactive liquid gravity flows into compressed air system during line blowdown activities	Worker exposure to ionizing radiation	Air check valve Shielding	Radiation Protection Program	S1	F3	E0	—	S1 based on exposure to facility worker only E0 based on no release to environment F3 based on configuration of flush/blowdown system without controls

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
E-04	Worker exposure to ionizing radiation due to unplugging transfer line	Excess solids causes line plug, worker exposure clearing plug	Worker exposure to ionizing radiation	Solids monitor Flow measurement	Radiation Protection Program	S1	F3	E0	—	S1 based on facility worker exposure E0 based on no release to environment F3 based on tank farms history for plugging lines during slurry transfer
E-05	Small release of radioactive or hazardous materials from the transfer line to the atmosphere due to flammable gas deflagration in line, transfer started	Buildup of solids and flammable gas in transfer line with ignition resulting in breach of transfer line; pumping is started without knowledge of breach	Surface Waste Leak	None	Ignition Controls Flam Gas Monitoring Controls Emergency Preparedness Transfer Controls (Waste Compatibility) Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL05
E-06	Release of radioactive or hazardous materials to the atmosphere due to flammable gas deflagration in the waste transfer line	Plugging of transfer line occurs, flammable gas builds up and is ignited resulting in a breach of transfer line; pumping is started (collection in pit)	Surface waste leak	None	Ignition Controls Flam Gas Monitoring Controls Emergency Preparedness Transfer Controls (Waste Compatibility) Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL10

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
E-07	Release of radioactive or hazardous material from the receiver tank ventilation system to the atmosphere due to HEPA filter failure due to high pressure	Compressed air used to blow down transfer line exceeds the HEPA filter capacity in the receiver tank causing filter failure and release of contaminants	Release of DST headspace aerosols and HEPA filter loading	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters (Linked to dP interlock)	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls (source term) HEPA Filter Efficiency (part of dP interlock) Process Instrumentation and Measuring and Test Equipment	S2	F1	E2	06X	S2/E2 based on analyzed accident, HEPA filter failure-exposure to high pressure F1 based on limitation of air flow through long 2" hose and limitation of the size of a normal portable air compressor
E-08	Personnel exposure to ionizing radiation due to high winds	High winds uncover overground transfer lines	Worker exposure to ionizing radiation	Shielding plate	Radiation Protection Program	S1	F3	E0	—	S1 based on worker exposure to ionizing radiation only E0 based on no release F3 based on anticipated high winds This hazardous condition derived from Project W-320 hazardous condition # W320-ABCD-TRANS15
E-09	Release of radioactive or hazardous material to the ground surface or atmosphere from a damaged overground transfer line due to wind blown missile	Missile caused by high wind or tornado penetrates overground transfer line causing surface or spray leak	Surface leak of radioactive waste	OTS Encasements and Connections Transfer Leak Detection System Shielding	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Tank Levels) Transfer Controls (Ground Radiation Survey) Emergency Preparedness (Response) Process Instrumentation and Measuring and Test Equipment Safety Management Programs	S2	F3	E2	10X	S2/E2 based on analyzed accident, natural phenomena-high wind F3 based on anticipated high winds

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
E-10	Release of radioactive or hazardous waste due to seismic induced damaged to a transfer line	Seismic event damages overground transfer line by ground motion resulting in spray release	Surface Waste Leak	Pipe Encasements Seismic Switch or Alarm Master Pump Shutdown System	Transfer Controls (Material Balance) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Safety Management Program	S2	F1	E2	33CX	S2/E2 based on analyzed accident, waste transfer leak F1 based on seismic event of sufficient magnitude to damage hose-in-hose transfer line considered extremely unlikely This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS11
E-11	Release of radioactive or hazardous waste due to seismic induced damaged to a transfer line	Seismic event damages transfer line by ground motion resulting subsurface leak remaining subsurface	Surface Waste Leak	Pipe Encasements Seismic Switch or Alarm Master Pump Shutdown System	Transfer Controls (Material Balance) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Safety Management Program	S0	F2	E2	—	S0 based on no worker exposure to a subsurface leak. E2 based on direct leak of tank waste to soil column. F2 based on seismic event of sufficient magnitude to damage transfer line considered unlikely This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS11
E-12	Release of radioactive or hazardous materials or hazardous waste from transfer line in tank 241-C-106 pit to atmosphere due to leak in line flush connection	Blank flange or hose connection left off flushing connection in pit after flushing and transfer initiated.	Surface waste leak from structure	Trans Leak Detect Systems Abovegrade Portions - Process Pits (Integrity) Trans Leak Detect Systems Tank Level Detect Systems Trans Sys Covers Abovegrade Portions - Process Pits (Splash and Splatter)	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Tank Levels) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Safety Management Programs	S2	F3	E2	33AX	S2/E2 based on analyzed accident F3 based on anticipated worker error This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-TRANS11

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
E-13	Release of radioactive or hazardous materials or hazardous waste from line in pit to the surface due to leak caused by mispositioned valve, cover plug in place	Air blow down valves left in flush configuration after flushing, cover plug remains in place on initiation of sluicing process, high capacity drain cover left on and pit overflows.	Radioactive liquid and hazardous liquid release to surface	Trans Leak Detect Systems Abovegrade Portions - Process Pits (Integrity) Trans Leak Detect Systems Tank Level Detect Systems Trans Sys Covers Abovegrade Portions - Process Pits (Splash and Splatter)	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Tank Levels) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Safety Management Programs	S2	F3	E2	33CX	S2/E2 based on analyzed accident F3 based on anticipated worker error This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-TRANS13
E-14	Release of radioactive or hazardous material from overground transfer hose to the ground due to a leaking connection	High temperature water flush degrades seal at hose joint connection causing leak to ground surface	Surface leak of tank waste	OTS Encasements and Connections OTS Vehicle Impact Barriers Transfer Leak Detection System Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Tank Levels) Transfer Controls (Ground Radiation Survey) Emergency Preparedness (Response Procedures) Process Instrumentation and Measuring and Test Equipment Safety Management Programs	S2	F3	E2	33CX	S2/E2 based on analyzed accident, waste transfer leak F3 based on operational experience where hose-in-hose transfer lines have leaked due to degradation caused by high temperatures Encasement for hose-in-hose transfer line drains to a pit which, if undetected would overflow. The design of the 241-C-106 transfer system does not include heating of flush water. Tank wastes and sluice water is well below the temperature that would cause connection failure.

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
E-15	Release of radioactive or hazardous materials to the surface due to ruptured transfer line	Overground transfer line break due to light aircraft strike	Surface waste leak	None	Emergency Preparedness Safety Management Program	S2	F0	E2	33CX	S2/E2 based on analyzed accident F0 based on HAZOP team consensus that aircraft crash was beyond extremely unlikely This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS32
E-16	Release of radioactive liquid from overflow of pit on receiver DST to soil surface due to transfer line leak	Jumper break or improper installation in pit with the high capacity drain cover on resulting in overflow of pit	Radioactive liquid and hazardous liquid release to surface	Transfer Leak Detection System Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Transfer System Cover Removal Program Safety Management Programs	S2	F3	E2	33CX	S2/E2 based on analyzed accident F3 based on anticipated jumper or connection leak This hazardous condition derived from Project W-320 hazardous condition # W320-B-FLUSH06
E-17	Release of radioactive liquid from overflow of pit on receiver DST to soil surface due to transfer line leak	Jumper break or improper installation in pit with the high capacity drain cover open and pit cover off	Radioactive liquid and hazardous liquid release to surface	Transfer Leak Detection System Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Transfer System Cover Removal Program Safety Management Programs	S2	F3	E2	33CX	S2/E2 based on analyzed accident F3 based on anticipated jumper or connection leak This hazardous condition derived from Project W-320 hazardous condition # W320-B-FLUSH06

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
E-18	Release of radioactive or hazardous materials from pit to atmosphere due to spray leak from jumper	Seismic event damages jumper and breaches cover block by ground motion resulting in spray release	Aerosolized radioactive waste release to atmosphere	Seismic Switch or Alarm Transfer Leak Detection System Pipe Encasements Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Ground Radiation Survey) Emergency Preparedness Safety Management Program	S2	F1	E2	33CX	S2/E2 based on analyzed accident F1 based on seismic event of sufficient magnitude to damage hose-in-hose piping considered extremely unlikely This hazardous condition derived from Project W-320 hazardous condition # W320-D-TRANS10
Node F: 241-C-106 Ventilation System										
F-01	Worker exposure to ionizing radiation when changing HEPA filters in 241-C-104 and 241-C-105	Active ventilation system in 241-C-106 draws additional air through the cascade lines to 241-C-104 and 241-C-105 HEPAs causing additional filter changes and unplanned exposure	Worker exposure to ionizing radiation	None	Radiation protection program	S1	F2	E0	—	S1 based on facility worker exposure only E0 based on no release to environment F2 based on operational history from past practice sluicing (Project W-320) showing only minimal pressure changes in cascaded tanks when active ventilation in 241-C-106 was operating

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
F-02	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere through failed filters due to moisture buildup	Moisture buildup on filters causes excessive back pressure and failure	Waste release to atmosphere	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S2	F3	E2	06X	S2/E2 conservatively based on analyzed accident HEPA filter failure-exposure to high temperature or pressure for active ventilation system. This would be S1/E1 for a passively ventilated system. F3 based on aerosol generation and filter loading during sluicing If moisture generation causes moisture buildup on HEPAs, then active ventilation could be used only when visibility is poor or a moisture separation system designed for the ventilation system This hazardous condition derived from Project W-320 hazardous condition # W320-ALL-TRANS01
F-03	Release of radioactive or hazardous materials from tank 241--C-106 to atmosphere due to HEPA filter failure	Sluicer breaks resulting in excessive aerosol generation in head space and release through failed HEPAs caused by HEPA plugging and high differential pressure	Waste release to atmosphere	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S2	F3	E2	06X	S2/E2 conservatively based on analyzed accident HEPA filter failure-exposure to high temperature or pressure for active ventilation system. This would be S1/E1 for a passively ventilated system. F3 based on aerosol generation and filter loading during sluicing This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS10

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
F-04	Release of radioactive or hazardous materials from tank 241-C-106 to soil column due to vacuum induced tank damage	Ventilation system fan on with tank level too low and or inlet damper closed results in vacuum uplift of tank bottom and leak to soil column	Waste release to ground	Inlet damper	Safety Management Programs Emergency Preparedness Maintain certain liquid level	S0	F3	E3	—	S0 based on no exposure to workers E3 based on waste leak to soil column F3 based on active ventilation system capable of uplifting tank bottom This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL03
F-05	Release of radioactive or hazardous materials from tanks connected 241-C-106 via cascade lines to the soil column due to vacuum induced tank damage	Ventilation system fan on with tank level too low and or inlet damper closed results in vacuum uplift of tank bottom of interconnected tanks and leak to soil column	Waste release to ground	Inlet damper	Safety Management Programs Emergency Preparedness Maintain certain liquid level	S0	F1	E3	—	S0 based on no exposure to workers E3 based on waste leak to soil column F1 based on flow restriction of cascade line coupled with anticipated leak paths around a closed ventilation damper plus having to have all in leakage to all cascaded tanks blocked off makes this an extremely unlikely condition.

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
F-06	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to vacuum induced tank damage	Fan controller failure resulting in excessive vacuum in tank, loop seal actuation and tank damage (dome damage)	Waste release to atmosphere	None	Safety Management Programs Emergency Preparedness	S2	F0	E2	13X	S2/E2 based on analyzed accident, tank failure due to excessive loads F0 based on ventilation system having insufficient vacuum to damage dome with no restriction or limitations on inlet damper This hazardous condition derived from Project W-320 hazardous condition # W320-BCD-ALL04 Accident analysis specifies structural failure due to excessive pressure (vacuum) is not credible.
F-07	Release of radioactive or hazardous materials to the atmosphere due to seismically induced structural failure of the ventilation system	Seismic event causes failure of ventilation system	Tank dome space aerosols and HEPA loading release to atmosphere	None	Safety Management Programs Emergency Preparedness	S2	F1	E2	14X	S2\E2 based on analyzed accident, unfiltered release F1 based on seismic event of sufficient magnitude to seriously damage portable ventilation system considered by HAZOP team to be extremely unlikely This hazardous condition derived from Project W-320 hazardous condition # W320-D-ALL10

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
F-08	Release of radioactive or hazardous materials from ventilation ducting due to high winds or tornado	High winds or tornado resulting in failed ventilation ducting and unfiltered release	Waste release to atmosphere	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S1	F3	E1	—	S1/E1 based on limited release from damaged ventilation system. F3 based on anticipated high wind Damage upstream of the ventilation fan would result in either a disabled vent system (complete break) and limited release. Damage downstream of the vent fan would not result in a release. This hazardous condition derived from Project W-320 hazardous condition # W320-ALL-TRANS02
F-09	Release of radioactive or hazardous materials from tank 241-C-106 ventilation system to atmosphere due to ventilation system leak	Ducting corrosion or seal deterioration undetermined during sluicing	Waste release to atmosphere	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S1	F3	E1	—	S1/E1 based on limited release from small leaks in ventilation system F3 based on anticipated corrosion or deterioration of HEPA seals in ventilation system with a small release affecting facility worker only This hazardous condition derived from Project W-320 hazardous condition # W320-D-VENT07
F-10	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to excessive vacuum	Excessive vacuum caused by human error (closing off inlet damper) in tank from ventilation system resulting in loop seal failure and unfiltered release	Waste release to atmosphere	Transfer Leak Detection System	Encasement Seal Loop Controls	S1	F3	E1	—	S1/E1 based on limited release through seal loop F3 based on ventilation having sufficient vacuum to empty seal loop This hazardous condition derived from Project W-320 hazardous condition # W320-D-VENT08

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
Node G: Receiver DST Ventilation System (241-AY-102)										
G-01	Release of radioactive or hazardous materials from receiver DST to atmosphere due to unfiltered release through failed HEPA filter	Excessive transfer flow resulting in increased aerosol generation and which loads HEPA filters causing high differential pressure and filter failure	Eventually exceed air emissions permit assumptions	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	06X	S2/E2 conservatively based on analyzed accident HEPA filter failure-exposure to high temperature or pressure for active ventilation system. F2 based on aerosol generation from transfer into tank unlikely to generate excessive aerosols This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS06
G-02	Release of radioactive or hazardous materials from receiver DST to atmosphere due to unfiltered release through failed HEPA filter	Distributor breaks off resulting in excessive aerosol generation in head space causing high differential pressure and failure of the HEPA	Release of radioactive or hazardous material to atmosphere	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	06X	S2/E2 conservatively based on analyzed accident HEPA filter failure-exposure to high temperature or pressure for active ventilation system. F2 based on aerosol generation from transfer into tank unlikely to generate excessive aerosols This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS08

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
G-03	Release of radioactive or hazardous materials from tank 241-AY-102 to atmosphere due to unfiltered release through failed HEPA filters	Heat loading from new waste cause loading of HEPA filters which fail by high differential pressure with aerosol release	Waste release to atmosphere	Ventilation Stack CAM Interlock System HEPA Filter dP Interlock System HEPA Filters	LCO Ventilation Stack CAM Interlock System LCO HEPA Filter dP Interlock System HEPA Filter Controls HEPA Filter Efficiency Process Instrumentation and Measuring and Test Equipment	S2	F0	E2	06X	S2/E2 conservatively based on analyzed accident HEPA filter failure-exposure to high temperature or pressure for active ventilation system. F0 based on 241-C-106 waste transferred into tank unlikely to generate enough heat to over-pressurize the ventilation system This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS11
G-04	Release of radioactive or hazardous materials from tank 241-AY-102 through failed filters due to tank bump	Cold water spray into tank (possible result of waste transfer) chills head space causing tank vacuum inducing resulting tank bump	Waste release to atmosphere	Temperature Monitoring Systems Tank 241-AY-102 Annulus Ventilation System	LCO Tank 241-AY-102 Annulus Ventilation System DST/AWF Tank Temperature Controls Process Instrumentation and Measuring and Test Equipment	S2	F0	E2	18AX	S2/E2 based on analyzed accident, unfiltered release F0 based on insufficient heat loading in tank waste to raise dome space temperature above ambient waste or service water temperature such that spray would cause a large pressure drop This hazardous condition derived from Project W-320 hazardous condition # W320-D-VENT04 Exhauster would have had to be down for a while to build up this much heat.

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
G-05	Release of radioactive or hazardous materials from 241-C-106 to the surface through pits and risers due to backflow of waste from receiver tank	Siphon of waste from Receiver tank to C-106 overfills tank with leak to ground	Tank waste leak to ground surface	Vacuum breaker Leak detection system	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Tank Levels) Emergency Preparedness (Response Procedures) Process Instrumentation and Measuring and Test Equipment Safety Management Programs	S2	F0	E2	33AX	S2/E2 based on analyzed accident, waste transfer leak F0 based on drop leg above waste in headspace thus creating a vacuum break Engineering design show no changes such that new drop legs or slurry distributors are to be installed in the receiver tank
Node H: Tank 241-C-106										
H-01	Release of radioactive or hazardous material to atmosphere from 241-C-106 due to unplanned nuclear criticality	Sluicing selectively removes neutron poisons resulting in criticality, steam generation and ventilation system failure	Release of neutrons radiation, radioactive fission gasses, and release of waste through breached filters	None	Nuclear Criticality Safety	S2	F0	E2	01X	S2/E2 based on analyzed accident, nuclear criticality F0 based on consensus of HAZOP team that retrieval or storage of 241-C-106 waste could not create a criticality
H-02	Release of radioactive or hazardous materials from tank 241-C-106 due to flammable gas deflagration in dome space	High waste temperature during transfer causing a steam bump which induces a flammable gas release/ignition	Waste release to atmosphere	SST Active Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system LCO Primary Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness Process Instrumentation and Measuring and Test Equipment	S2	F1	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F1 based on consensus of HAZOP team that waste volume is extremely unlikely to have a steam release and then generate sufficient gas to reach LFL This hazardous condition derived from Project W-320 hazardous condition # W320-A-TRANS04

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
H-03	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to flammable gas deflagration	Temperature out of specification causing a steam bump when level is lowered resulting in release/ignition of a flammable gas	Waste release to atmosphere	SST Active Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system LCO Primary Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness Process Instrumentation and Measuring and Test Equipment	S2	F1	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F1 based on consensus of HAZOP team that waste volume is extremely unlikely to have a steam release and then generate sufficient gas to reach LFL This hazardous condition derived from Project W-320 hazardous condition # W320-A-TRANS05
H-04	Release of radioactive or hazardous materials from tank 241-C-106 pit to the atmosphere due to spray leak from flammable gas deflagration in pit	Flammable gas collects in pit and ignites, lifting cover block, which falls onto piping in pit resulting in damage to transfer lines and spray release	Aerosolized radioactive waste release to atmosphere	Pit Cover Pit Leak Detector	Ignition Controls Flam Gas Monitoring Controls Emergency Preparedness Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, waste transfer leak F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL This hazardous condition derived from Project W-320 hazardous condition # W320-B-TRANS27
H-05	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to organic waste fire	Formation of organic layer in tank during sluicing and subsequent ignition of organics	Waste release to atmosphere	None	Ignition Controls (heat source) Emergency Preparedness (Response Procedures) HEPA Filter Controls (Source Term) Transfer Controls (Waste Compatibility) Process Instrumentation and Measurement and Testing Equipment	S3	F0	E3	09X	S3/E3 based on analyzed accident, organic solvent fire F0 based on water sluicing combined with no indication of solvents remaining after initial sluicing This hazardous condition derived from Project W-320 hazardous condition # W320-B-ALL10

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
H-06	Release of radioactive or hazardous materials from tank 241-C-106 to atmosphere due to organic waste fire	Loss of ventilation for many months, dry out of waste and subsequent ignition of organics	Waste release to atmosphere	None	Ignition Controls (heat source) Emergency Preparedness (Response Procedures) HEPA Filter Controls (Source Term) Process Instrumentation and Measurement and Testing Equipment	S3	F0	E3	09X	S3/E3 based on analyzed accident, organic solvent fire F0 based on water sluicing combined with no indication of large amounts of solvents remaining after initial sluicing This hazardous condition derived from Project W-320 hazardous condition # W320-B-VENT08
H-07	Release of ammonia gas from tank to atmosphere due to burp which exposes facility personnel to hazardous gases	Sluicing causes release of ammonia	Hazardous gas release to atmosphere	HEGA Filters	Safety Management Program (Industrial Safety)	S1	F3	E1	—	S1/E1 based on limited amount of waste in tank F3 based on anticipated release of ammonia This hazardous condition derived from Project W-320 hazardous condition # W320-B-TERM01
H-08	Release of radioactive liquid waste from tank 241-C-106 to soil subsurface due to large water intrusion	Large water intrusion resulting in high hydrostatic pressure and tank breach (Service water, surface flood, excessive transfer, or cascade)	Below grade radioactive liquid and hazardous liquid release	Service Water Flow Totalizer	Transfer Controls (Tank Levels) Emergency Preparedness Process Instrumentation and Measuring and Test Equipment Tank Service Water Intrusion Monitoring Program Transfer System Cover Removal Program Safety Management Programs	S0	F3	E2	—	S2/E2 based on analyzed accident F3 based on unlimited water available trough sluicing system hookup to service water supply system This hazardous condition derived from Project W-320 hazardous condition # W320-B-ALL11

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
Node I: Receiver Double-Shell Tank (241-AY-102)										
I-01	Release of radioactive or hazardous material from damaged 241-AY-102 ventilation system due to mixing of incompatible material	Transferred waste reacts with waste in tank causing steam or gas generation which pressurizes the tank causing failure of the HEPA filters	Waste release to atmosphere	None	Transfer Controls (pH) Safety Management Programs (Hazardous Mtl Protection Program)	S2	F0	E2	03X	S2\E2 based on analyzed accident, mixing of incompatible materials-tank pressurization F0 based on consensus of HAZOP team that sluiced waste will be compatible with any waste in the DST receiver tank
I-02	Large release of radioactive or hazardous materials from receiver DST to the atmosphere due to flammable gas deflagration	Influx of cold water spray into tank causing excessive vacuum with a large flammable gas release as a result of waste transfer; gas is ignited	Waste release to atmosphere	DST/AWF Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system Flammability Controls Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness Instrumentation and Measuring and Test Equipment	S3	F0	E3	04X	S3/E3 based on analyzed accident, flammable gas deflagration F0 based on consensus of HAZOP team that there not enough difference between waste or sluice water temperature and tank headspace temperature to create sufficient vacuum to induce large GRE This hazardous condition derived from Project W-320 hazardous condition # W320-D-VENT13

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
I-03	Release of radioactive or hazardous materials from tank 241-AY-102 to atmosphere due to flammable gas deflagration	Pumping of more solids than anticipated, annulus cooling not adequate, waste is overheated causing a tank bump that results in GRE with ignition	Waste release to atmosphere	DST/AWF Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness Instrumentation and Measuring and Test Equipment	S3	F0	E3	04X	S3/E3 based on analyzed accident, flammable gas deflagration F0 based on consensus of HAZOP team that the heat loading caused by transfer of the remaining waste in 241-C-106 is, in and of itself, insufficient to induce a GRE This hazardous condition derived from Project W-320 hazardous condition # W320-D-PUMP04
I-04	Release of liquid waste into annulus of receiver DST due to tank equipment penetrating tank liner	Distributor/dropleg breaks off dropping into tank and penetrates tank liner resulting in leakage to annulus	Loss of tank	Primary Tank Leak Detection System	LCO Primary Tank Leak Detection System Process Instrumentation and Measuring and Test Equipment	S0	F0	E0	—	S0 based on no worker exposure E0 based on no release to environment F0 based on consensus of HAZOP team that drop leg is not massive enough to penetrate tank bottom This hazardous condition derived from Project W-320 hazardous condition # W320-ABCD-TRANS04
I-05	Release of toxic material from Tank 241-AY-102 to the atmosphere due to mixing of incompatible material	Waste transfer reacts with waste in tank resulting in the release of toxic gasses	Toxic Gas released through ventilation system	High Efficiency Gas Absorbers	Industrial Hygiene Program Emergency Response Procedures	S2	F0	E2	23X	S2/E2 based on analyzed accident, mixing of incompatible material, toxic vapor generation F0 based on consensus of HAZOP team that sluiced waste will be compatible with any waste in the DST receiver tank

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
I-06	Release of radioactive or hazardous material from receiver tank to the ground surface due to overfilling	Unlimited sluicing and waste transfer overfills receiver tank with overflow through pit to ground	Release of tank waste to ground surface	Transfer Leak Detection System Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Tank Levels) Emergency Preparedness (Response Procedures) Process Instrumentation and Measuring and Test Equipment Safety Management Programs	S2	F3	E2	33AX	S2/E2 based on analyzed accident, waste transfer leak F3 based on unlimited amount of sluice water from Hanford service water lines
I-07	Release of radioactive or hazardous material from receiver tank to the ground surface due to overfilling	Line flush overfills receiver tank with overflow through pit to ground	Release of tank waste to ground surface	Transfer Leak Detection System Master Pump Shutdown System	LCO Trans. Leak Detection System Transfer Controls (Material Balance) Transfer Controls (Tank Levels) Emergency Preparedness (Response Procedures) Process Instrumentation and Measuring and Test Equipment Safety Management Programs	S2	F3	E2	33AX	S2/E2 based on analyzed accident, waste transfer leak F3 based on unlimited amount of sluice water from Hanford service water lines
Node J: Instrumentation and Controls										
J-01	Release of radioactive or hazardous material from 241-C-106 to the atmosphere due to a flammable Gas deflagration	In-tank instrumentation fails causing a spark which ignites flammable gas causing damage to the ventilation system	Release of tank waste to the atmosphere	SST Active Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness Process Instrumentation and Measuring and Test Equipment	S2	F2	E2	05X	S2/E2 based on analyzed accident, flammable gas deflagration F2 based on consensus of HAZOP team that waste volume is unlikely to generate sufficient gas to reach LFL

Table E-1. Hazards and Operability Study (HAZOP) Results for the Phase 1 Retrieval of Single-Shell Tank 241-C-106 for Closure. (40 sheets)

ID	Hazardous Condition	Cause	Consequence	Suggested SSC	Suggested TSR	Initial Safety Cons NC	Initial Freq NC	Env Cons	Rep Acc	Remarks
J-02	Release of radioactive or hazardous material from 241-AY-102 to the atmosphere due to a flammable Gas deflagration	In-tank instrumentation fails causing a spark which ignites flammable gas causing damage to the ventilation system	Release of tank waste to the atmosphere	DST/AWF Vent. System	LCO Vent Stack Cam Interlock System LCO Vent system Ignition Controls Flam Gas Monitoring Controls HEPA Filter Controls Emergency Preparedness Process Instrumentation and Measuring and Test Equipment	S2	F3	E2	04X	S2/E2 based on analyzed accident, flammable gas deflagration F3 based on analyzed accident, flammable gas deflagration in DST

Notes:

HNF-SD-WM-SAR-067, 2002, *Tank Farms Final Safety Analysis Report*, Rev. 3-J, CH2M HILL Hanford Group, Inc., Richland, Washington.

AWF = aging waste facility.
CAM = continuous air monitor.
DST = double-shell tank.
FSAR = *Tank Farms Final Safety Analysis Report*.
GRE = gas release event.
HAZOP = hazard and operability study
HEPA = high-efficiency particulate air.
ID = identification.
LCO = limited condition for operation.
LFL = lower flammability limit.
NC = no control.
OTS = overground transfer system.
SSC = structures, systems, and components.
SST = single-shell tank.
TSR = technical safety requirement.

APPENDIX F

BEST-BASIS INVENTORY

SST 241-C-106

DST 241-AN-106

DST 241-AY-102

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APPENDIX F

Best-Basis Inventory Report for SST 241-C-106

This report prepared especially for William_H_Grams@rl.gov on 12/18/2002

Some of the reports herein may contain data that has not been reviewed or edited. The data will have been reviewed or edited as of the date that a Tank Interpretive Report (TIR) is prepared and approved. This tank has no TIR, use the data with this caution in mind.

Tank: 241-C-106

Sampling Events:
- 6C-96-1
- 6C-96-10
- 6C-96-11
- 6C-96-12
- 6C-96-13
- 6C-96-14
- 6C-96-15
- 6C-96-16
- 6C-96-17
- 6C-96-2
- 6C-96-3
- 6C-96-4
- 6C-96-5
- 6C-96-6
- 6C-96-7
- 6C-96-8

Reports:
- Best-Basis Inventory Without Details

Constituent Groups:
- Anions
- Inorganics
- Metals/Nonmetals
- Organics
- PCBs
- Physical Properties
- Radionuclides

Table of Contents

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Tank 241-C-106 Best-Basis Inventory Without Details F-4

Data Dictionary to Reports in this Document

Report	Field	Description
Best-Basis Inventory Without Details		Contains best-basis inventory without details for the contents of the Hanford waste tanks.
	Analyte	The name of the constituent used for reporting purposes.
	Waste Phase	Waste Phase is the phase of waste to which the concentration data is applicable (e.g., supernatant, saltcake, sludge, liquid, solid, etc.).
	Waste Type	Waste Type is the waste type as defined in HDW Rev. 4 or as defined by "templates" (e.g., SMMA1, SMMT1, etc.).
	Volume	Volume of the waste phase
	Concentration	Concentration reported in uCi/g, ug/g, uCi/mL, or ug/mL
	Inventory	Best-basis inventory estimate, reported in kg or Ci
	Basis	The basis for the inventory value.
	Comment	Further information to clarify the information in the table.

Tank 241-C-106 Best-Basis Inventory Without Details

Decayed To: January 1, 2001

Effective Date: January 1, 2001

Published On: November 12, 2001

Best-Basis Derivation

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
Al	Sludge	AR (Solid)	23 kL	5.24E+04 µg/g	1.83E+03 kg	S	
Al	Supernatant	AR (Liquid)	115 kL	1.75E+03 µg/g	2.29E+02 kg	S	
Al	**Total**	--	**138 kL**	--	**2.06E+03 kg**	--	
Bi	Sludge	AR (Solid)	23 kL	3.70E+00 µg/g	1.11E-1 kg	E	
Bi	Supernatant	AR (Liquid)	115 kL	5.53E+00 µg/g	6.68E-1 kg	E	
Bi	**Total**	--	**138 kL**	--	**7.79E-1 kg**	--	
Ca	Sludge	AR (Solid)	23 kL	2.25E+03 µg/g	7.85E+01 kg	S	
Ca	Supernatant	AR (Liquid)	115 kL	2.93E+01 µg/g	3.78E+00 kg	S	
Ca	**Total**	--	**138 kL**	--	**8.23E+01 kg**	--	
Cl	Sludge	AR (Solid)	23 kL	1.08E+02 µg/g	3.78E+00 kg	S	
Cl	Supernatant	AR (Liquid)	115 kL	2.18E+02 µg/g	2.84E+01 kg	S	
Cl	**Total**	--	**138 kL**	--	**3.21E+01 kg**	--	
TIC as CO3	Sludge	AR (Solid)	23 kL	9.05E+04 µg/g	3.25E+03 kg	S	
TIC as CO3	Supernatant	AR (Liquid)	115 kL	7.68E+04 µg/g	9.98E+03 kg	S	
TIC as CO3	**Total**	--	**138 kL**	--	**1.32E+04 kg**	--	
Cr	Sludge	AR (Solid)	23 kL	1.63E+03 µg/g	5.71E+01 kg	S	
Cr	Supernatant	AR (Liquid)	115 kL	3.53E+01 µg/g	4.63E+00 kg	S	
Cr	**Total**	--	**138 kL**	--	**6.18E+01 kg**	--	
F	Sludge	AR (Solid)	23 kL	6.81E+01 µg/g	2.38E+00 kg	S	
F	Supernatant	AR (Liquid)	115 kL	1.10E+02 µg/g	1.43E+01 kg	S	
F	**Total**	--	**138 kL**	--	**1.67E+01 kg**	--	
Fe	Sludge	AR (Solid)	23 kL	8.73E+04 µg/g	3.05E+03 kg	S	
Fe	Supernatant	AR (Liquid)	115 kL	1.37E+01 µg/g	1.79E+00 kg	S	
Fe	**Total**	--	**138 kL**	--	**3.06E+03 kg**	--	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
Hg	Sludge	AR (Solid)	23 kL	1.26E+02 μg/g	4.39E+00 kg	S	
Hg	Supernatant	AR (Liquid)	115 kL	5.04E-1 μg/g	6.55E-2 kg	S	
Hg	**Total**	--	**138 kL**	--	**4.46E+00 kg**	--	
K	Sludge	AR (Solid)	23 kL	6.03E+02 μg/g	2.11E+01 kg	S	
K	Supernatant	AR (Liquid)	115 kL	6.63E+02 μg/g	8.69E+01 kg	S	
K	**Total**	--	**138 kL**	--	**1.08E+02 kg**	--	
La	Sludge	AR (Solid)	23 kL	3.52E+02 μg/g	1.23E+01 kg	S	
La	Supernatant	AR (Liquid)	115 kL	0.00E+00 μg/g	0.00E+00 kg	E	
La	**Total**	--	**138 kL**	--	**1.23E+01 kg**	--	
Mn	Sludge	AR (Solid)	23 kL	2.17E+04 μg/g	7.59E+02 kg	S	
Mn	Supernatant	AR (Liquid)	115 kL	2.63E+00 μg/g	3.41E-1 kg	S	
Mn	**Total**	--	**138 kL**	--	**7.59E+02 kg**	--	
Na	Sludge	AR (Solid)	23 kL	7.02E+04 μg/g	2.45E+03 kg	S	
Na	Supernatant	AR (Liquid)	115 kL	7.26E+04 μg/g	9.51E+03 kg	S	
Na	**Total**	--	**138 kL**	--	**1.20E+04 kg**	--	
Ni	Sludge	AR (Solid)	23 kL	3.03E+03 μg/g	1.06E+02 kg	S	
Ni	Supernatant	AR (Liquid)	115 kL	4.79E+00 μg/g	6.23E-1 kg	S	
Ni	**Total**	--	**138 kL**	--	**1.06E+02 kg**	--	
NO_2	Sludge	AR (Solid)	23 kL	2.31E+03 μg/g	8.08E+01 kg	S	
NO_2	Supernatant	AR (Liquid)	115 kL	1.10E+04 μg/g	1.45E+03 kg	S	
NO_2	**Total**	--	**138 kL**	--	**1.53E+03 kg**	--	
NO_3	Sludge	AR (Solid)	23 kL	3.36E+02 μg/g	1.18E+01 kg	S	
NO_3	Supernatant	AR (Liquid)	115 kL	5.01E+02 μg/g	6.51E+01 kg	S	
NO_3	**Total**	--	**138 kL**	--	**7.69E+01 kg**	--	Upper bounding estimate
Pb	Sludge	AR (Solid)	23 kL	4.50E+03 μg/g	1.57E+02 kg	S	
Pb	Supernatant	AR (Liquid)	115 kL	2.80E+01 μg/g	3.38E+00 kg	E	
Pb	**Total**	--	**138 kL**	--	**1.61E+02 kg**	--	
PO_4	Sludge	AR (Solid)	23 kL	1.07E+04 μg/g	3.75E+02 kg	S	
PO_4	Supernatant	AR (Liquid)	115 kL	4.30E+03 μg/g	5.64E+02 kg	S	
PO_4	**Total**	--	**138 kL**	--	**9.39E+02 kg**	--	
Si	Sludge	AR (Solid)	23 kL	1.19E+03 μg/g	4.15E+01 kg	S	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
Si	Supernatant	AR (Liquid)	115 kL	2.01E+02 µg/g	2.63E+01 kg	S	
Si	**Total**	--	**138 kL**	--	**6.78E+01 kg**	--	
SO_4	Sludge	AR (Solid)	23 kL	1.73E+03 µg/g	6.06E+01 kg	S	
SO_4	Supernatant	AR (Liquid)	115 kL	3.21E+03 µg/g	4.21E+02 kg	S	
SO_4	**Total**	--	**138 kL**	--	**4.82E+02 kg**	--	
Sr	Sludge	AR (Solid)	23 kL	1.86E+02 µg/g	6.49E+00 kg	S	
Sr	Supernatant	AR (Liquid)	115 kL	6.45E-2 µg/g	8.38E-3 kg	C	
Sr	**Total**	--	**138 kL**	--	**6.50E+00 kg**	--	Liquid based on ^{90}Sr
TOC	Sludge	AR (Solid)	23 kL	4.65E+03 µg/g	1.67E+02 kg	S	
TOC	Supernatant	AR (Liquid)	115 kL	2.76E+03 µg/g	3.58E+02 kg	S	
TOC	**Total**	--	**138 kL**	--	**5.25E+02 kg**	--	
UTOTAL	Sludge	AR (Solid)	23 kL	1.18E+03 µg/g	4.11E+01 kg	S	
UTOTAL	Supernatant	AR (Liquid)	115 kL	6.91E+02 µg/g	9.07E+01 kg	S	
UTOTAL	**Total**	--	**138 kL**	--	**1.32E+02 kg**	--	
Zr	Sludge	AR (Solid)	23 kL	7.59E+01 µg/g	2.65E+00 kg	S	
Zr	Supernatant	AR (Liquid)	115 kL	9.52E-3 µg/g	1.15E-3 kg	E	
Zr	**Total**	--	**138 kL**	--	**2.66E+00 kg**	--	
^{3}H	Sludge	AR (Solid)	23 kL	4.04E-3 µCi/g	1.45E-1 Ci	S	
^{3}H	Supernatant	AR (Liquid)	115 kL	1.08E-2 µCi/g	1.40E+00 Ci	S	
^{3}H	**Total**	--	**138 kL**	--	**1.55E+00 Ci**	--	
^{14}C	Sludge	AR (Solid)	23 kL	2.31E-4 µCi/g	8.28E-3 Ci	S	
^{14}C	Supernatant	AR (Liquid)	115 kL	3.77E-4 µCi/g	4.91E-2 Ci	S	
^{14}C	**Total**	--	**138 kL**	--	**5.73E-2 Ci**	--	
^{59}Ni	Sludge	AR (Solid)	23 kL	2.05E-1 µCi/g	6.13E+00 Ci	E	
^{59}Ni	Supernatant	AR (Liquid)	115 kL	3.30E-3 µCi/g	3.99E-1 Ci	E	
^{59}Ni	**Total**	--	**138 kL**	--	**6.53E+00 Ci**	--	
^{60}Co	Sludge	AR (Solid)	23 kL	8.23E-3 µCi/g	2.46E-1 Ci	E	
^{60}Co	Supernatant	AR (Liquid)	115 kL	8.89E-3 µCi/g	1.16E+00 Ci	S	
^{60}Co	**Total**	--	**138 kL**	--	**1.40E+00 Ci**	--	
^{63}Ni	Sludge	AR (Solid)	23 kL	1.91E+01 µCi/g	5.71E+02 Ci	E	
^{63}Ni	Supernatant	AR (Liquid)	115 kL	3.07E-1 µCi/g	3.70E+01 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{63}Ni	**Total**	--	**138 kL**	--	**6.08E+02 Ci**	--	
^{79}Se	Sludge	AR (Solid)	23 kL	9.27E-3 µCi/g	2.77E-1 Ci	E	
^{79}Se	Supernatant	AR (Liquid)	115 kL	8.40E-5 µCi/g	1.09E-2 Ci	S	
^{79}Se	**Total**	--	**138 kL**	--	**2.88E-1 Ci**	--	
^{90}Sr	Sludge	AR (Solid)	23 kL	7.86E+03 µCi/g	2.82E+05 Ci	S	
^{90}Sr	Supernatant	AR (Liquid)	115 kL	2.64E+00 µCi/g	3.43E+02 Ci	S	
^{90}Sr	**Total**	--	**138 kL**	--	**2.82E+05 Ci**	--	
^{90}Y	Sludge	AR (Solid)	23 kL	7.86E+03 µCi/g	2.82E+05 Ci	C	
^{90}Y	Supernatant	AR (Liquid)	115 kL	2.64E+00 µCi/g	3.43E+02 Ci	C	
^{90}Y	**Total**	--	**138 kL**	--	**2.82E+05 Ci**	--	Based on ^{90}Sr
^{93}Zr	Sludge	AR (Solid)	23 kL	3.89E-1 µCi/g	1.16E+01 Ci	E	
^{93}Zr	Supernatant	AR (Liquid)	115 kL	2.28E-2 µCi/g	2.75E+00 Ci	E	
^{93}Zr	**Total**	--	**138 kL**	--	**1.44E+01 Ci**	--	
^{93m}Nb	Sludge	AR (Solid)	23 kL	3.63E-1 µCi/g	1.08E+01 Ci	E	
^{93m}Nb	Supernatant	AR (Liquid)	115 kL	1.59E-2 µCi/g	1.92E+00 Ci	E	
^{93m}Nb	**Total**	--	**138 kL**	--	**1.28E+01 Ci**	--	
^{99}Tc	Sludge	AR (Solid)	23 kL	2.88E-2 µCi/g	1.03E+00 Ci	S	
^{99}Tc	Supernatant	AR (Liquid)	115 kL	1.62E-2 µCi/g	2.11E+00 Ci	S	
^{99}Tc	**Total**	--	**138 kL**	--	**3.14E+00 Ci**	--	
^{106}Ru	Sludge	AR (Solid)	23 kL	1.93E-7 µCi/g	5.77E-6 Ci	E	
^{106}Ru	Supernatant	AR (Liquid)	115 kL	9.24E-8 µCi/g	1.12E-5 Ci	E	
^{106}Ru	**Total**	--	**138 kL**	--	**1.69E-5 Ci**	--	
^{113m}Cd	Sludge	AR (Solid)	23 kL	1.95E-1 µCi/g	5.84E+00 Ci	E	
^{113m}Cd	Supernatant	AR (Liquid)	115 kL	9.80E-2 µCi/g	1.18E+01 Ci	E	
^{113m}Cd	**Total**	--	**138 kL**	--	**1.77E+01 Ci**	--	
^{125}Sb	Sludge	AR (Solid)	23 kL	1.34E-2 µCi/g	4.01E-1 Ci	E	
^{125}Sb	Supernatant	AR (Liquid)	115 kL	2.01E-2 µCi/g	2.43E+00 Ci	E	
^{125}Sb	**Total**	--	**138 kL**	--	**2.83E+00 Ci**	--	
^{126}Sn	Sludge	AR (Solid)	23 kL	6.04E-2 µCi/g	1.81E+00 Ci	E	
^{126}Sn	Supernatant	AR (Liquid)	115 kL	2.73E-3 µCi/g	3.30E-1 Ci	E	
^{126}Sn	**Total**	--	**138 kL**	--	**2.14E+00 Ci**	--	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{129}I	Sludge	AR (Solid)	23 kL	2.77E-4 µCi/g	8.28E-3 Ci	E	
^{129}I	Supernatant	AR (Liquid)	115 kL	6.72E-5 µCi/g	8.73E-3 Ci	S	
^{129}I	**Total**	**--**	**138 kL**	**--**	**1.70E-2 Ci**	--	Upper bounding estimate
^{134}Cs	Sludge	AR (Solid)	23 kL	3.36E-4 µCi/g	1.00E-2 Ci	E	
^{134}Cs	Supernatant	AR (Liquid)	115 kL	5.02E-4 µCi/g	6.06E-2 Ci	E	
^{134}Cs	**Total**	**--**	**138 kL**	**--**	**7.07E-2 Ci**	--	
^{137}Cs	Sludge	AR (Solid)	23 kL	3.17E+02 µCi/g	1.14E+04 Ci	S	
^{137}Cs	Supernatant	AR (Liquid)	115 kL	4.74E+01 µCi/g	6.16E+03 Ci	S	
^{137}Cs	**Total**	**--**	**138 kL**	**--**	**1.75E+04 Ci**	--	
^{137m}Ba	Sludge	AR (Solid)	23 kL	3.00E+02 µCi/g	1.08E+04 Ci	C	
^{137m}Ba	Supernatant	AR (Liquid)	115 kL	4.48E+01 µCi/g	5.83E+03 Ci	C	
^{137m}Ba	**Total**	**--**	**138 kL**	**--**	**1.66E+04 Ci**	--	Based on ^{137}Cs
^{151}Sm	Sludge	AR (Solid)	23 kL	3.37E+02 µCi/g	1.01E+04 Ci	E	
^{151}Sm	Supernatant	AR (Liquid)	115 kL	1.51E+01 µCi/g	1.82E+03 Ci	E	
^{151}Sm	**Total**	**--**	**138 kL**	**--**	**1.19E+04 Ci**	--	
^{152}Eu	Sludge	AR (Solid)	23 kL	9.53E-2 µCi/g	2.85E+00 Ci	E	
^{152}Eu	Supernatant	AR (Liquid)	115 kL	3.59E-3 µCi/g	4.33E-1 Ci	E	
^{152}Eu	**Total**	**--**	**138 kL**	**--**	**3.28E+00 Ci**	--	
^{154}Eu	Sludge	AR (Solid)	23 kL	7.36E+00 µCi/g	2.64E+02 Ci	S	
^{154}Eu	Supernatant	AR (Liquid)	115 kL	2.47E-2 µCi/g	3.21E+00 Ci	S	
^{154}Eu	**Total**	**--**	**138 kL**	**--**	**2.67E+02 Ci**	--	
^{155}Eu	Sludge	AR (Solid)	23 kL	5.08E+00 µCi/g	1.82E+02 Ci	S	
^{155}Eu	Supernatant	AR (Liquid)	115 kL	5.35E-2 µCi/g	6.95E+00 Ci	S	
^{155}Eu	**Total**	**--**	**138 kL**	**--**	**1.89E+02 Ci**	--	
^{226}Ra	Sludge	AR (Solid)	23 kL	1.31E-5 µCi/g	3.93E-4 Ci	E	
^{226}Ra	Supernatant	AR (Liquid)	115 kL	1.41E-7 µCi/g	1.70E-5 Ci	E	
^{226}Ra	**Total**	**--**	**138 kL**	**--**	**4.10E-4 Ci**	--	
^{227}Ac	Sludge	AR (Solid)	23 kL	7.39E-5 µCi/g	2.21E-3 Ci	E	
^{227}Ac	Supernatant	AR (Liquid)	115 kL	8.20E-7 µCi/g	9.90E-5 Ci	E	
^{227}Ac	**Total**	**--**	**138 kL**	**--**	**2.31E-3 Ci**	--	
^{228}Ra	Sludge	AR (Solid)	23 kL	8.22E-7 µCi/g	2.46E-5 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{228}Ra	Supernatant	AR (Liquid)	115 kL	5.74E-8 µCi/g	6.93E-6 Ci	E	
^{228}Ra	**Total**	--	**138 kL**	--	**3.15E-5 Ci**	--	
^{229}Th	Sludge	AR (Solid)	23 kL	7.04E-7 µCi/g	2.10E-5 Ci	E	
^{229}Th	Supernatant	AR (Liquid)	115 kL	2.66E-8 µCi/g	3.21E-6 Ci	E	
^{229}Th	**Total**	--	**138 kL**		**2.43E-5 Ci**	--	
^{231}Pa	Sludge	AR (Solid)	23 kL	9.43E-5 µCi/g	2.82E-3 Ci	E	
^{231}Pa	Supernatant	AR (Liquid)	115 kL	4.55E-6 µCi/g	5.50E-4 Ci	E	
^{231}Pa	**Total**	--	**138 kL**	--	**3.37E-3 Ci**	--	
^{232}Th	Sludge	AR (Solid)	23 kL	7.04E-5 µCi/g	2.53E-3 Ci	S	
^{232}Th	Supernatant	AR (Liquid)	115 kL	7.92E-8 µCi/g	1.03E-5 Ci	S	
^{232}Th	**Total**	--	**138 kL**	--	**2.54E-3 Ci**	--	
^{232}U	Sludge	AR (Solid)	23 kL	4.73E-6 µCi/g	1.65E-4 Ci	C	
^{232}U	Supernatant	AR (Liquid)	115 kL	2.78E-6 µCi/g	3.64E-4 Ci	C	
^{232}U	**Total**	--	**138 kL**	--	**5.30E-4 Ci**	--	Based on UTOTAL and HDW model isotopic distribution
^{233}U	Sludge	AR (Solid)	23 kL	1.95E-5 µCi/g	6.81E-4 Ci	C	
^{233}U	Supernatant	AR (Liquid)	115 kL	1.15E-5 µCi/g	1.50E-3 Ci	C	
^{233}U	**Total**	--	**138 kL**	--	**2.18E-3 Ci**	--	Based on UTOTAL and HDW model isotopic distribution
^{234}U	Sludge	AR (Solid)	23 kL	3.84E-4 µCi/g	1.34E-2 Ci	C	
^{234}U	Supernatant	AR (Liquid)	115 kL	2.26E-4 µCi/g	2.96E-2 Ci	C	
^{234}U	**Total**	--	**138 kL**	--	**4.31E-2 Ci**	--	Based on UTOTAL and HDW model isotopic distribution
^{235}U	Sludge	AR (Solid)	23 kL	1.64E-5 µCi/g	5.73E-4 Ci	C	
^{235}U	Supernatant	AR (Liquid)	115 kL	9.64E-6 µCi/g	1.26E-3 Ci	C	
^{235}U	**Total**	--	**138 kL**	--	**1.84E-3 Ci**	--	Based on UTOTAL and HDW model isotopic distribution
^{236}U	Sludge	AR (Solid)	23 kL	6.83E-6 µCi/g	2.39E-4 Ci	C	
^{236}U	Supernatant	AR (Liquid)	115 kL	4.02E-6 µCi/g	5.27E-4 Ci	C	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{236}U	**Total**	--	**138 kL**	--	**7.66E-4 Ci**	--	Based on UTOTAL and HDW model isotopic distribution
^{237}Np	Sludge	AR (Solid)	23 kL	4.62E-3 µCi/g	1.66E-1 Ci	S	
^{237}Np	Supernatant	AR (Liquid)	115 kL	7.44E-4 µCi/g	9.66E-2 Ci	S	
^{237}Np	**Total**	--	**138 kL**	--	**2.62E-1 Ci**	--	
^{238}Pu	Sludge	AR (Solid)	23 kL	9.70E-2 µCi/g	3.48E+00 Ci	C	
^{238}Pu	Supernatant	AR (Liquid)	115 kL	1.63E-4 µCi/g	2.12E-2 Ci	C	
^{238}Pu	**Total**	--	**138 kL**	--	**3.50E+00 Ci**	--	Based on ^{239}Pu and HDW model isotopic distribution
^{238}U	Sludge	AR (Solid)	23 kL	3.93E-4 µCi/g	1.37E-2 Ci	C	
^{238}U	Supernatant	AR (Liquid)	115 kL	2.31E-4 µCi/g	3.03E-2 Ci	C	
^{238}U	**Total**	--	**138 kL**		**4.40E-2 Ci**	--	Based on UTOTAL and HDW model isotopic distribution
^{239}Pu	Sludge	AR (Solid)	23 kL	2.09E+00 µCi/g	7.52E+01 Ci	C	
^{239}Pu	Supernatant	AR (Liquid)	115 kL	3.52E-3 µCi/g	4.57E-1 Ci	C	
^{239}Pu	**Total**	--	**138 kL**	--	**7.56E+01 Ci**	--	Based on $^{239/240}$Pu and HDW model isotopic distribution
^{240}Pu	Sludge	AR (Solid)	23 kL	4.28E-1 µCi/g	1.54E+01 Ci	C	
^{240}Pu	Supernatant	AR (Liquid)	115 kL	7.18E-4 µCi/g	9.33E-2 Ci	C	
^{240}Pu	**Total**	--	**138 kL**	--	**1.54E+01 Ci**	--	Based on $^{239/240}$Pu and HDW model isotopic distribution
^{241}Am	Sludge	AR (Solid)	23 kL	6.27E+00 µCi/g	2.25E+02 Ci	E	
^{241}Am	Supernatant	AR (Liquid)	115 kL	4.09E-4 µCi/g	5.36E-2 Ci	E	
^{241}Am	**Total**	--	**138 kL**	--	**2.25E+02 Ci**	--	
^{241}Pu	Sludge	AR (Solid)	23 kL	5.14E+00 µCi/g	1.84E+02 Ci	E	
^{241}Pu	Supernatant	AR (Liquid)	115 kL	8.57E-3 µCi/g	1.12E+00 Ci	E	
^{241}Pu	**Total**	--	**138 kL**	--	**1.85E+02 Ci**	--	Based on ^{239}Pu and HDW model isotopic distribution
^{242}Cm	Sludge	AR (Solid)	23 kL	9.53E-3 µCi/g	3.42E-1 Ci	C	
^{242}Cm	Supernatant	AR (Liquid)	115 kL	1.19E-4 µCi/g	1.43E-2 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{242}Cm	**Total**	--	**138 kL**	--	**3.56E-1 Ci**	--	Sludge based on ^{241}Am and HDW model isotopic distribution
^{242}Pu	Sludge	AR (Solid)	23 kL	4.56E-5 µCi/g	1.64E-3 Ci	C	
^{242}Pu	Supernatant	AR (Liquid)	115 kL	7.66E-8 µCi/g	9.95E-6 Ci	C	
^{242}Pu	**Total**	--	**138 kL**	--	**1.65E-3 Ci**	--	Based on ^{239}Pu and HDW model isotopic distribution
^{243}Am	Sludge	AR (Solid)	23 kL	6.75E-5 µCi/g	2.02E-3 Ci	E	
^{243}Am	Supernatant	AR (Liquid)	115 kL	1.50E-6 µCi/g	1.81E-4 Ci	E	
^{243}Am	**Total**	--	**138 kL**	--	**2.20E-3 Ci**	--	Sludge based on ^{241}Am and HDW model isotopic distribution
^{243}Cm	Sludge	AR (Solid)	23 kL	7.64E-4 µCi/g	2.74E-2 Ci	C	
^{243}Cm	Supernatant	AR (Liquid)	115 kL	5.82E-6 µCi/g	7.03E-4 Ci	E	
^{243}Cm	**Total**	--	**138 kL**	--	**2.81E-2 Ci**	--	Sludge based on ^{241}Am and HDW model isotopic distribution
^{244}Cm	Sludge	AR (Solid)	23 kL	1.62E-2 µCi/g	5.82E-1 Ci	C	
^{244}Cm	Supernatant	AR (Liquid)	115 kL	1.74E-4 µCi/g	2.10E-2 Ci	E	
^{244}Cm	**Total**	--	**138 kL**	--	**2.10E-2 Ci**	--	Sludge based on ^{241}Am and HDW model isotopic distribution

Best-Basis Inventory Report for DST 241-AN-106

This report prepared especially for William_H_Grams@rl.gov on 12/18/2002

Some of the reports herein may contain data that has not been reviewed or edited. The data will have been reviewed or edited as of the date that a Tank Interpretive Report (TIR) is prepared and approved. The TIR for this tank was approved on April 22, 2002.

Tank: 241-AN-106

Sampling Events:
- 6AN-01-01
- 6AN-01-02
- 6AN-02-01A
- 6AN-02-01B
- 6AN-02-FB1
- 6AN-95-1
- 6AN-95-2
- 6AN-95-3
- 6AN-95-4
- 6AN-95-5
- 6AN-95-6
- 6AN-95-7
- 6AN-95-8
- 6AN-95-9

Reports:
- Best-Basis Inventory Without Details

Constituent Groups:
- Anions
- Inorganics
- Metals/Nonmetals
- Organics
- PCBs
- Physical Properties
- Radionuclides

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Tank 241-AY-102 Best-Basis Inventory Without Details 28

Data Dictionary to Reports in this Document

Report	Field	Description
Best-Basis Inventory Without Details		**Contains best-basis inventory without details for the contents of the Hanford waste tanks.**
	Analyte	**The name of the constituent used for reporting purposes.**
	Waste Phase	**Waste Phase is the phase of waste to which the concentration data is applicable (e.g., supernatant, saltcake, sludge, liquid, solid, etc.).**
	Waste Type	**Waste Type is the waste type as defined in HDW Rev. 4 or as defined by "templates" (e.g., SMMA1, SMMT1, etc.).**
	Volume	**Volume of the waste phase**
	Concentration	**Concentration reported in uCi/g, ug/g, uCi/mL, or ug/mL**
	Inventory	**Best-Basis Inventory estimate, reported in kg or Ci**
	Basis	**The basis for the inventory value.**
	Comment	**Further information to clarify the information in the table.**

Tank 241-AN-106 Best-Basis Inventory Without Details
Decayed To: January 1, 2001
Effective Date: July 1, 2002
Published On: October 1, 2002
Best-Basis Derivation

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
Al	Saltcake	A1-SltCk (Solid)	65 kL	2.41E+04 µg/g	2.48E+03 kg	E	
Al	Supernatant	A1-SltCk (Liquid)	110 kL	1.67E+03 µg/g	2.26E+02 kg	S	
Al	**Total**	--	**175 kL**	--	**2.70E+03 kg**	--	.
Bi	Saltcake	A1-SltCk (Solid)	65 kL	1.72E+02 µg/g	1.77E+01 kg	E	
Bi	Supernatant	A1-SltCk (Liquid)	110 kL	1.16E+01 µg/g	1.57E+00 kg	S	
Bi	**Total**	--	**175 kL**	--	**1.92E+01 kg**	--	.
Ca	Saltcake	A1-SltCk (Solid)	65 kL	4.34E+02 µg/g	4.46E+01 kg	E	
Ca	Supernatant	A1-SltCk (Liquid)	110 kL	5.96E+00 µg/g	7.81E-1 kg	E	
Ca	**Total**	--	**175 kL**	--	**4.54E+01 kg**	--	.
Cl	Saltcake	A1-SltCk (Solid)	65 kL	5.80E+03 µg/g	5.96E+02 kg	E	
Cl	Supernatant	A1-SltCk (Liquid)	110 kL	9.44E+02 µg/g	1.28E+02 kg	S	
Cl	**Total**	--	**175 kL**	--	**7.23E+02 kg**	--	.
TIC as CO_3	Saltcake	A1-SltCk (Solid)	65 kL	8.26E+04 µg/g	8.48E+03 kg	E	
TIC as CO_3	Supernatant	A1-SltCk (Liquid)	110 kL	2.97E+04 µg/g	4.02E+03 kg	S	
TIC as CO_3	**Total**	--	**175 kL**	--	**1.25E+04 kg**	--	.
Cr	Saltcake	A1-SltCk (Solid)	65 kL	4.50E+03 µg/g	4.62E+02 kg	E	
Cr	Supernatant	A1-SltCk (Liquid)	110 kL	2.99E+02 µg/g	4.05E+01 kg	S	
Cr	**Total**	--	**175 kL**	--	**5.03E+02 kg**	--	.
F	Saltcake	A1-SltCk (Solid)	65 kL	6.93E+02 µg/g	7.12E+01 kg	E	
F	Supernatant	A1-SltCk (Liquid)	110 kL	3.30E+03 µg/g	4.47E+02 kg	S	
F	**Total**	--	**175 kL**	--	**5.18E+02 kg**	--	.
Fe	Saltcake	A1-SltCk (Solid)	65 kL	3.21E+02 µg/g	3.30E+01 kg	E	
Fe	Supernatant	A1-SltCk (Liquid)	110 kL	1.14E+00 µg/g	1.49E-1 kg	E	
Fe	**Total**	--	**175 kL**	--	**3.31E+01 kg**	--	.

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
Hg	Saltcake	A1-SltCk (Solid)	65 kL	0.00E+00 µg/g	0.00E+00 kg	E	
Hg	Supernatant	A1-SltCk (Liquid)	110 kL	0.00E+00 µg/g	0.00E+00 kg	E	
Hg	**Total**	--	**175 kL**	--	**0.00E+00 kg**	--	**Internal Memo 6N100-00-051 dated 04/27/00 from B.A.Higley to T.T. Tran (Higley 2000)**
K	Saltcake	A1-SltCk (Solid)	65 kL	3.40E+03 µg/g	3.49E+02 kg	E	
K	Supernatant	A1-SltCk (Liquid)	110 kL	7.00E+03 µg/g	9.48E+02 kg	S	
K	**Total**	--	**175 kL**	--	**1.30E+03 kg**	--	
La	Saltcake	A1-SltCk (Solid)	65 kL	6.39E+01 µg/g	6.56E+00 kg	E	
La	Supernatant	A1-SltCk (Liquid)	110 kL	2.65E-1 µg/g	4.67E-2 kg	E	
La	**Total**	--	**175 kL**	--	**6.61E+00 kg**	--	.
Mn	Saltcake	A1-SltCk (Solid)	65 kL	5.34E+01 µg/g	5.48E+00 kg	E	
Mn	Supernatant	A1-SltCk (Liquid)	110 kL	1.16E+00 µg/g	1.57E-1 kg	S	
Mn	**Total**	--	**175 kL**	--	**5.64E+00 kg**	--	
Na	Saltcake	A1-SltCk (Solid)	65 kL	1.75E+05 µg/g	1.80E+04 kg	E	
Na	Supernatant	A1-SltCk (Liquid)	110 kL	9.35E+04 µg/g	1.28E+04 kg	E	
Na	**Total**	--	**175 kL**	--	**3.07E+04 kg**	--	.
Ni	Saltcake	A1-SltCk (Solid)	65 kL	2.56E+02 µg/g	2.63E+01 kg	E	
Ni	Supernatant	A1-SltCk (Liquid)	110 kL	3.42E+00 µg/g	4.62E-1 kg	S	
Ni	**Total**	--	**175 kL**	--	**2.68E+01 kg**	--	
NO_2	Saltcake	A1-SltCk (Solid)	65 kL	8.53E+04 µg/g	8.76E+03 kg	E	
NO_2	Supernatant	A1-SltCk (Liquid)	110 kL	1.47E+04 µg/g	1.99E+03 kg	S	
NO_2	**Total**	--	**175 kL**	--	**1.08E+04 kg**	--	.
NO_3	Saltcake	A1-SltCk (Solid)	65 kL	1.07E+05 µg/g	1.10E+04 kg	E	
NO_3	Supernatant	A1-SltCk (Liquid)	110 kL	4.25E+04 µg/g	5.75E+03 kg	S	
NO_3	**Total**	--	**175 kL**	--	**1.67E+04 kg**	--	.
Pb	Saltcake	A1-SltCk (Solid)	65 kL	8.94E+01 µg/g	9.18E+00 kg	E	
Pb	Supernatant	A1-SltCk (Liquid)	110 kL	1.16E+01 µg/g	1.57E+00 kg	S	
Pb	**Total**	--	**175 kL**	-	**1.07E+01 kg**	--	**Upper bounding estimate**
PO_4	Saltcake	A1-SltCk (Solid)	65 kL	1.53E+04 µg/g	1.57E+03 kg	E	
PO_4	Supernatant	A1-SltCk (Liquid)	110 kL	1.35E+03 µg/g	1.82E+02 kg	S	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
PO_4	**Total**	--	**175 kL**	--	**1.75E+03 kg**	--	.
Si	Saltcake	A1-SltCk (Solid)	65 kL	4.28E+02 µg/g	4.40E+01 kg	E	
Si	Supernatant	A1-SltCk (Liquid)	110 kL	3.40E+01 µg/g	4.59E+00 kg	S	
Si	**Total**	--	**175 kL**	--	**4.85E+01 kg**	--	
SO_4	Saltcake	A1-SltCk (Solid)	65 kL	1.49E+04 µg/g	1.53E+03 kg	E	
SO_4	Supernatant	A1-SltCk (Liquid)	110 kL	3.02E+03 µg/g	4.08E+02 kg	S	
SO_4	**Total**	--	**175 kL**	--	**1.94E+03 kg**	--	.
Sr	Saltcake	A1-SltCk (Solid)	65 kL	2.52E+01 µg/g	2.59E+00 kg	E	
Sr	Supernatant	A1-SltCk (Liquid)	110 kL	5.11E-4 µg/g	6.69E-5 kg	C	
Sr	**Total**	--	**175 kL**	--	**2.59E+00 kg**	--	**Supernate based on ^{90}Sr**
TOC	Saltcake	A1-SltCk (Solid)	65 kL	8.25E+03 µg/g	8.47E+02 kg	E	
TOC	Supernatant	A1-SltCk (Liquid)	110 kL	1.30E+03 µg/g	1.76E+02 kg	S	
TOC	**Total**	--	**175 kL**	--	**1.02E+03 kg**	--	.
UTOTAL	Saltcake	A1-SltCk (Solid)	65 kL	7.94E+02 µg/g	8.15E+01 kg	E	
UTOTAL	Supernatant	A1-SltCk (Liquid)	110 kL	2.90E+01 µg/g	3.92E+00 kg	S	
UTOTAL	**Total**	--	**175 kL**	--	**8.55E+01 kg**	--	
Zr	Saltcake	A1-SltCk (Solid)	65 kL	8.28E+01 µg/g	8.50E+00 kg	E	
Zr	Supernatant	A1-SltCk (Liquid)	110 kL	1.16E+00 µg/g	1.57E-1 kg	S	
Zr	**Total**	--	**175 kL**	--	**8.66E+00 kg**	--	
^{3}H	Saltcake	A1-SltCk (Solid)	65 kL	3.03E-2 µCi/g	3.11E+00 Ci	E	
^{3}H	Supernatant	A1-SltCk (Liquid)	110 kL	3.67E-2 µCi/g	6.46E+00 Ci	E	
^{3}H	**Total**	--	**175 kL**	--	**9.57E+00 Ci**	--	
^{14}C	Saltcake	A1-SltCk (Solid)	65 kL	1.88E-2 µCi/g	1.93E+00 Ci	E	
^{14}C	Supernatant	A1-SltCk (Liquid)	110 kL	5.96E-3 µCi/g	1.05E+00 Ci	E	
^{14}C	**Total**	--	**175 kL**	--	**2.98E+00 Ci**	--	
^{59}Ni	Saltcake	A1-SltCk (Solid)	65 kL	1.51E-3 µCi/g	1.55E-1 Ci	E	
^{59}Ni	Supernatant	A1-SltCk (Liquid)	110 kL	7.79E-5 µCi/g	1.37E-2 Ci	E	
^{59}Ni	**Total**	--	**175 kL**	--	**1.69E-1 Ci**	--	
^{60}Co	Saltcake	A1-SltCk (Solid)	65 kL	1.65E-2 µCi/g	1.70E+00 Ci	E	
^{60}Co	Supernatant	A1-SltCk (Liquid)	110 kL	1.90E-3 µCi/g	3.34E-1 Ci	E	
^{60}Co	**Total**	--	**175 kL**	--	**2.03E+00 Ci**	--	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{63}Ni	Saltcake	A1-SltCk (Solid)	65 kL	1.43E-1 µCi/g	1.47E+01 Ci	E	
^{63}Ni	Supernatant	A1-SltCk (Liquid)	110 kL	7.34E-3 µCi/g	1.29E+00 Ci	E	
^{63}Ni	**Total**	--	**175 kL**	--	**1.60E+01 Ci**	--	
^{79}Se	Saltcake	A1-SltCk (Solid)	65 kL	2.31E-4 µCi/g	2.37E-2 Ci	E	
^{79}Se	Supernatant	A1-SltCk (Liquid)	110 kL	3.60E-5 µCi/g	6.34E-3 Ci	E	
^{79}Se	**Total**	--	**175 kL**	--	**3.01E-2 Ci**	--	
^{90}Sr	Saltcake	A1-SltCk (Solid)	65 kL	3.47E+01 µCi/g	3.56E+03 Ci	E	
^{90}Sr	Supernatant	A1-SltCk (Liquid)	110 kL	2.09E-2 µCi/g	2.74E+00 Ci	E	
^{90}Sr	**Total**	--	**175 kL**	--	**3.57E+03 Ci**	--	
^{90}Y	Saltcake	A1-SltCk (Solid)	65 kL	3.47E+01 µCi/g	3.56E+03 Ci	C	
^{90}Y	Supernatant	A1-SltCk (Liquid)	110 kL	2.09E-2 µCi/g	2.74E+00 Ci	C	
^{90}Y	**Total**	--	**175 kL**	--	**3.57E+03 Ci**	--	**Based on ^{90}Sr**
^{93}Zr	Saltcake	A1-SltCk (Solid)	65 kL	1.14E-2 µCi/g	1.17E+00 Ci	E	
^{93}Zr	Supernatant	A1-SltCk (Liquid)	110 kL	1.78E-3 µCi/g	3.13E-1 Ci	E	
^{93}Zr	**Total**	--	**175 kL**	--	**1.48E+00 Ci**	--	
^{93m}Nb	Saltcake	A1-SltCk (Solid)	65 kL	9.15E-3 µCi/g	9.40E-1 Ci	E	
^{93m}Nb	Supernatant	A1-SltCk (Liquid)	110 kL	1.43E-3 µCi/g	2.51E-1 Ci	E	
^{93m}Nb	**Total**	--	**175 kL**	--	**1.19E+00 Ci**	--	
^{99}Tc	Saltcake	A1-SltCk (Solid)	65 kL	5.80E-2 µCi/g	5.96E+00 Ci	E	
^{99}Tc	Supernatant	A1-SltCk (Liquid)	110 kL	7.02E-2 µCi/g	1.24E+01 Ci	E	
^{99}Tc	**Total**	--	**175 kL**	--	**1.83E+01 Ci**	--	
^{106}Ru	Saltcake	A1-SltCk (Solid)	65 kL	4.97E-8 µCi/g	5.11E-6 Ci	E	
^{106}Ru	Supernatant	A1-SltCk (Liquid)	110 kL	7.74E-9 µCi/g	1.36E-6 Ci	E	
^{106}Ru	**Total**	--	**175 kL**	--	**6.47E-6 Ci**	--	
^{113m}Cd	Saltcake	A1-SltCk (Solid)	65 kL	4.52E-2 µCi/g	4.64E+00 Ci	E	
^{113m}Cd	Supernatant	A1-SltCk (Liquid)	110 kL	7.03E-3 µCi/g	1.24E+00 Ci	E	
^{113m}Cd	**Total**	--	**175 kL**	--	**5.88E+00 Ci**	--	
^{125}Sb	Saltcake	A1-SltCk (Solid)	65 kL	2.48E-2 µCi/g	2.55E+00 Ci	E	
^{125}Sb	Supernatant	A1-SltCk (Liquid)	110 kL	3.87E-3 µCi/g	6.81E-1 Ci	E	
^{125}Sb	**Total**	--	**175 kL**	--	**3.23E+00 Ci**	--	
^{126}Sn	Saltcake	A1-SltCk (Solid)	65 kL	1.40E-3 µCi/g	1.43E-1 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{126}Sn	Supernatant	A1-SltCk (Liquid)	110 kL	2.17E-4 µCi/g	3.83E-2 Ci	E	
^{126}Sn	**Total**	--	**175 kL**	--	**1.82E-1 Ci**	--	
^{129}I	Saltcake	A1-SltCk (Solid)	65 kL	1.12E-4 µCi/g	1.15E-2 Ci	E	
^{129}I	Supernatant	A1-SltCk (Liquid)	110 kL	1.36E-4 µCi/g	2.39E-2 Ci	E	
^{129}I	**Total**	--	**175 kL**	--	**3.54E-2 Ci**	--	
^{134}Cs	Saltcake	A1-SltCk (Solid)	65 kL	1.08E-4 µCi/g	1.11E-2 Ci	E	
^{134}Cs	Supernatant	A1-SltCk (Liquid)	110 kL	9.71E-5 µCi/g	1.71E-2 Ci	E	
^{134}Cs	**Total**	--	**175 kL**	--	**2.82E-2 Ci**	--	
^{137}Cs	Saltcake	A1-SltCk (Solid)	65 kL	1.49E+02 µCi/g	1.53E+04 Ci	E	
^{137}Cs	Supernatant	A1-SltCk (Liquid)	110 kL	4.25E+01 µCi/g	5.57E+03 Ci	E	
^{137}Cs	**Total**	--	**175 kL**	--	**2.09E+04 Ci**	--	.
^{137m}Ba	Saltcake	A1-SltCk (Solid)	65 kL	1.41E+02 µCi/g	1.45E+04 Ci	C	
^{137m}Ba	Supernatant	A1-SltCk (Liquid)	110 kL	4.02E+01 µCi/g	5.27E+03 Ci	C	
^{137m}Ba	**Total**	--	**175 kL**	--	**1.97E+04 Ci**	--	**Based on ^{137}Cs**
^{151}Sm	Saltcake	A1-SltCk (Solid)	65 kL	7.69E+00 µCi/g	7.90E+02 Ci	E	
^{151}Sm	Supernatant	A1-SltCk (Liquid)	110 kL	1.20E+00 µCi/g	2.11E+02 Ci	E	
^{151}Sm	**Total**	--	**175 kL**	--	**1.00E+03 Ci**	--	
^{152}Eu	Saltcake	A1-SltCk (Solid)	65 kL	2.32E-3 µCi/g	2.39E-1 Ci	E	
^{152}Eu	Supernatant	A1-SltCk (Liquid)	110 kL	3.62E-4 µCi/g	6.36E-2 Ci	E	
^{152}Eu	**Total**	--	**175 kL**	--	**3.02E-1 Ci**	--	
^{154}Eu	Saltcake	A1-SltCk (Solid)	65 kL	2.64E-1 µCi/g	2.72E+01 Ci	E	
^{154}Eu	Supernatant	A1-SltCk (Liquid)	110 kL	4.11E-2 µCi/g	7.24E+00 Ci	E	
^{154}Eu	**Total**	--	**175 kL**	--	**3.44E+01 Ci**	--	
^{155}Eu	Saltcake	A1-SltCk (Solid)	65 kL	7.29E-2 µCi/g	7.49E+00 Ci	E	
^{155}Eu	Supernatant	A1-SltCk (Liquid)	110 kL	1.13E-2 µCi/g	1.99E+00 Ci	E	
^{155}Eu	**Total**	--	**175 kL**	--	**9.48E+00 Ci**	--	
^{226}Ra	Saltcake	A1-SltCk (Solid)	65 kL	9.28E-8 µCi/g	9.53E-6 Ci	E	
^{226}Ra	Supernatant	A1-SltCk (Liquid)	110 kL	1.44E-8 µCi/g	2.54E-6 Ci	E	
^{226}Ra	**Total**	--	**175 kL**	--	**1.21E-5 Ci**	--	
^{227}Ac	Saltcake	A1-SltCk (Solid)	65 kL	9.46E-7 µCi/g	9.72E-5 Ci	E	
^{227}Ac	Supernatant	A1-SltCk (Liquid)	110 kL	1.47E-7 µCi/g	2.59E-5 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{227}Ac	**Total**	--	**175 kL**	--	**1.23E-4 Ci**	--	
^{228}Ra	Saltcake	A1-SltCk (Solid)	65 kL	1.12E-4 µCi/g	1.15E-2 Ci	E	
^{228}Ra	Supernatant	A1-SltCk (Liquid)	110 kL	1.74E-5 µCi/g	3.06E-3 Ci	E	
^{228}Ra	**Total**	--	**175 kL**	--	**1.45E-2 Ci**	--	
^{229}Th	Saltcake	A1-SltCk (Solid)	65 kL	4.74E-6 µCi/g	4.86E-4 Ci	E	
^{229}Th	Supernatant	A1-SltCk (Liquid)	110 kL	7.38E-7 µCi/g	1.30E-4 Ci	E	
^{229}Th	**Total**	--	**175 kL**	--	**6.16E-4 Ci**	--	
^{231}Pa	Saltcake	A1-SltCk (Solid)	65 kL	2.55E-6 µCi/g	2.62E-4 Ci	E	
^{231}Pa	Supernatant	A1-SltCk (Liquid)	110 kL	3.98E-7 µCi/g	7.00E-5 Ci	E	
^{231}Pa	**Total**	--	**175 kL**	--	**3.32E-4 Ci**	--	
^{232}Th	Saltcake	A1-SltCk (Solid)	65 kL	2.49E-5 µCi/g	2.56E-3 Ci	E	
^{232}Th	Supernatant	A1-SltCk (Liquid)	110 kL	3.87E-6 µCi/g	6.81E-4 Ci	E	
^{232}Th	**Total**	--	**175 kL**	--	**3.24E-3 Ci**	--	
^{232}U	Saltcake	A1-SltCk (Solid)	65 kL	2.10E-4 µCi/g	2.16E-2 Ci	E	
^{232}U	Supernatant	A1-SltCk (Liquid)	110 kL	7.68E-6 µCi/g	1.04E-3 Ci	C	
^{232}U	**Total**	--	**175 kL**	--	**2.26E-2 Ci**	--	**Liquid based on UTOTAL and template isotopic distribution**
^{233}U	Saltcake	A1-SltCk (Solid)	65 kL	8.64E-4 µCi/g	8.87E-2 Ci	E	
^{233}U	Supernatant	A1-SltCk (Liquid)	110 kL	3.16E-5 µCi/g	4.27E-3 Ci	C	
^{233}U	**Total**	--	**175 kL**	--	**9.30E-2 Ci**	--	**Liquid based on UTOTAL and template isotopic distribution**
^{234}U	Saltcake	A1-SltCk (Solid)	65 kL	2.93E-4 µCi/g	3.01E-2 Ci	E	
^{234}U	Supernatant	A1-SltCk (Liquid)	110 kL	1.07E-5 µCi/g	1.45E-3 Ci	C	
^{234}U	**Total**	--	**175 kL**	--	**3.15E-2 Ci**	--	**Liquid based on UTOTAL and template isotopic distribution**
^{235}U	Saltcake	A1-SltCk (Solid)	65 kL	1.21E-5 µCi/g	1.24E-3 Ci	E	
^{235}U	Supernatant	A1-SltCk (Liquid)	110 kL	4.41E-7 µCi/g	5.96E-5 Ci	C	
^{235}U	**Total**	--	**175 kL**	--	**1.30E-3 Ci**	--	**Liquid based on UTOTAL and template isotopic distribution**

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{236}U	Saltcake	A1-SltCk (Solid)	65 kL	1.03E-5 µCi/g	1.06E-3 Ci	E	
^{236}U	Supernatant	A1-SltCk (Liquid)	110 kL	3.75E-7 µCi/g	5.07E-5 Ci	C	
^{236}U	**Total**	**--**	**175 kL**	**--**	**1.11E-3 Ci**	**--**	**Liquid based on UTOTAL and template isotopic distribution**
^{237}Np	Saltcake	A1-SltCk (Solid)	65 kL	2.05E-4 µCi/g	2.11E-2 Ci	E	
^{237}Np	Supernatant	A1-SltCk (Liquid)	110 kL	2.49E-4 µCi/g	4.37E-2 Ci	E	
^{237}Np	**Total**	**--**	**175 kL**	**--**	**6.48E-2 Ci**	**--**	**.**
^{238}Pu	Saltcake	A1-SltCk (Solid)	65 kL	2.03E-2 µCi/g	2.09E+00 Ci	E	
^{238}Pu	Supernatant	A1-SltCk (Liquid)	110 kL	2.17E-5 µCi/g	2.84E-3 Ci	C	
^{238}Pu	**Total**	**--**	**175 kL**	**--**	**2.09E+00 Ci**	**--**	**Liquid based on Total Alpha and template isotopic distribution**
^{238}U	Saltcake	A1-SltCk (Solid)	65 kL	2.65E-4 µCi/g	2.72E-2 Ci	E	
^{238}U	Supernatant	A1-SltCk (Liquid)	110 kL	9.66E-6 µCi/g	1.31E-3 Ci	C	
^{238}U	**Total**	**--**	**175 kL**	**--**	**2.85E-2 Ci**	**--**	**Liquid based on UTOTAL and template isotopic distribution**
^{239}Pu	Saltcake	A1-SltCk (Solid)	65 kL	6.02E-1 µCi/g	6.18E+01 Ci	E	
^{239}Pu	Supernatant	A1-SltCk (Liquid)	110 kL	6.43E-4 µCi/g	8.42E-2 Ci	C	
^{239}Pu	**Total**	**--**	**175 kL**	**--**	**6.19E+01 Ci**	**--**	**Liquid based on Total Alpha and template isotopic distribution**
^{240}Pu	Saltcake	A1-SltCk (Solid)	65 kL	1.02E-1 µCi/g	1.05E+01 Ci	E	
^{240}Pu	Supernatant	A1-SltCk (Liquid)	110 kL	1.08E-4 µCi/g	1.42E-2 Ci	C	
^{240}Pu	**Total**	**--**	**175 kL**	**--**	**1.05E+01 Ci**	**--**	**Liquid based on Total Alpha and template isotopic distribution**
^{241}Am	Saltcake	A1-SltCk (Solid)	65 kL	9.23E-2 µCi/g	9.48E+00 Ci	E	
^{241}Am	Supernatant	A1-SltCk (Liquid)	110 kL	3.48E-3 µCi/g	4.56E-1 Ci	C	
^{241}Am	**Total**	**--**	**175 kL**	**--**	**9.94E+00 Ci**	**--**	**Liquid based on Total Alpha and template isotopic distribution**
^{241}Pu	Saltcake	A1-SltCk (Solid)	65 kL	1.05E+00 µCi/g	1.08E+02 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{241}Pu	Supernatant	A1-SltCk (Liquid)	110 kL	1.12E-3 µCi/g	1.46E-1 Ci	C	
^{241}Pu	**Total**	**--**	**175 kL**	**--**	**1.08E+02 Ci**	**--**	**Liquid based on Total Alpha and template isotopic distribution**
^{242}Cm	Saltcake	A1-SltCk (Solid)	65 kL	1.32E-6 µCi/g	1.36E-4 Ci	E	
^{242}Cm	Supernatant	A1-SltCk (Liquid)	110 kL	7.51E-9 µCi/g	9.83E-7 Ci	C	
^{242}Cm	**Total**	**--**	**175 kL**	**--**	**1.37E-4 Ci**	**--**	**Liquid based on Total Alpha and template isotopic distribution**
^{242}Pu	Saltcake	A1-SltCk (Solid)	65 kL	9.21E-6 µCi/g	9.46E-4 Ci	E	
^{242}Pu	Supernatant	A1-SltCk (Liquid)	110 kL	9.85E-9 µCi/g	1.29E-6 Ci	C	
^{242}Pu	**Total**	**--**	**175 kL**	**--**	**9.47E-4 Ci**	**--**	**Liquid based on Total Alpha and template isotopic distribution**
^{243}Am	Saltcake	A1-SltCk (Solid)	65 kL	3.95E-6 µCi/g	4.05E-4 Ci	E	
^{243}Am	Supernatant	A1-SltCk (Liquid)	110 kL	1.75E-7 µCi/g	2.28E-5 Ci	C	
^{243}Am	**Total**	**--**	**175 kL**	**--**	**4.28E-4 Ci**	**--**	**Liquid based on Total Alpha and template isotopic distribution**
^{243}Cm	Saltcake	A1-SltCk (Solid)	65 kL	2.35E-8 µCi/g	2.42E-6 Ci	E	
^{243}Cm	Supernatant	A1-SltCk (Liquid)	110 kL	1.34E-10 µCi/g	1.75E-8 Ci	C	
^{243}Cm	**Total**	**--**	**175 kL**	**--**	**2.43E-6 Ci**	**--**	**Liquid based on Total Alpha and template isotopic distribution**
^{244}Cm	Saltcake	A1-SltCk (Solid)	65 kL	6.22E-7 µCi/g	6.39E-5 Ci	E	
^{244}Cm	Supernatant	A1-SltCk (Liquid)	110 kL	3.52E-9 µCi/g	4.61E-7 Ci	C	
^{244}Cm	**Total**	**--**	**175 kL**	**--**	**4.61E-7 Ci**	**--**	**Liquid based on Total Alpha and template isotopic distribution**

Best-Basis Inventory Report for DST 241-AY-102

This report prepared especially for William_H_Grams@rl.gov on 12/27/2002

Some of the reports herein may contain data that has not been reviewed or edited. The data will have been reviewed or edited as of the date that a Tank Interpretive Report (TIR) is prepared and approved. The TIR for this tank was approved on December 20, 2000.

Tank: 241-AY-102

Sampling Events:
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- 2AY-01-01
- 2AY-01-02
- 2AY-01-03
- 2AY-01-04
- 2AY-01-05
- 2AY-01-06
- 2AY-01-07
- 2AY-01-08
- 2AY-02-01
- 2AY-02-01FB
- 2AY-02-02
- 2AY-02-03
- 2AY-02-04
- 2AY-02-05
- 2AY-02-06
- 2AY-95-01
- 2AY-95-02
- 2AY-95-03
- 2AY-95-04
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- 2AY-96-16
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- 2AY-96-18
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- 2AY-97-3
- 2AY-97-4
- 2AY-97-5

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300
594AY1
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Data Dictionary to Reports in this Document

Report	Field	Description
Best-Basis Inventory Without Details		Contains best-basis inventory without details for the contents of the Hanford waste tanks.
	Analyte	The name of the constituent used for reporting purposes.
	Waste Phase	Waste Phase is the phase of waste to which the concentration data is applicable (e.g., supernatant, saltcake, sludge, liquid, solid, etc.).
	Waste Type	Waste Type is the waste type as defined in HDW Rev. 4 or as defined by "templates" (e.g., SMMA1, SMMT1, etc.).
	Volume	Volume of the waste phase
	Concentration	Concentration reported in uCi/g, ug/g, uCi/mL, or ug/mL
	Inventory	Best-Basis Inventory estimate, reported in kg or Ci
	Basis	The basis for the inventory value.
	Comment	Further information to clarify the information in the table.

Tank 241-AY-102 Best-Basis Inventory Without Details
Decayed To: January 1, 2001
Effective Date: January 1, 2002
Published On: April 8, 2002
Best-Basis Derivation

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
Al	Sludge (Liquids)	BL (Liquid)	97 kL	9.11E+01 µg/g	9.72E+00 kg	S	
Al	Sludge (Solids)	BL (Solid)	548 kL	4.87E+04 µg/g	3.87E+04 kg	S	
Al	Supernatant	BL (Liquid)	1924 kL	1.17E+03 µg/g	2.59E+03 kg	S	
Al	**Total**	--	**2569 kL**	--	**4.13E+04 kg**	--	
Bi	Sludge (Liquids)	BL (Liquid)	97 kL	0.00E+00 µg/g	0.00E+00 kg	E	
Bi	Sludge (Solids)	BL (Solid)	548 kL	1.91E+02 µg/g	1.52E+02 kg	S	
Bi	Supernatant	BL (Liquid)	1924 kL	0.00E+00 µg/g	0.00E+00 kg	E	
Bi	**Total**	--	**2569 kL**	--	**1.52E+02 kg**	--	
Ca	Sludge (Liquids)	BL (Liquid)	97 kL	9.18E+00 µg/g	9.80E-1 kg	S	
Ca	Sludge (Solids)	BL (Solid)	548 kL	5.78E+03 µg/g	4.59E+03 kg	S	
Ca	Supernatant	BL (Liquid)	1924 kL	1.63E+01 µg/g	3.60E+01 kg	S	
Ca	**Total**	--	**2569 kL**	--	**4.63E+03 kg**	--	
Cl	Sludge (Liquids)	BL (Liquid)	97 kL	1.34E+02 µg/g	1.43E+01 kg	S	
Cl	Sludge (Solids)	BL (Solid)	548 kL	1.56E+02 µg/g	1.24E+02 kg	S	
Cl	Supernatant	BL (Liquid)	1924 kL	9.61E+01 µg/g	2.13E+02 kg	S	
Cl	**Total**	--	**2569 kL**	--	**3.51E+02 kg**	--	
TIC as CO_3	Sludge (Liquids)	BL (Liquid)	97 kL	4.66E+04 µg/g	4.97E+03 kg	S	
TIC as CO_3	Sludge (Solids)	BL (Solid)	548 kL	6.86E+04 µg/g	5.45E+04 kg	S	
TIC as CO3	Supernatant	BL (Liquid)	1924 kL	4.30E+04 µg/g	9.51E+04 kg	S	
TIC as CO_3	**Total**	--	**2569 kL**	--	**1.55E+05 kg**	--	
Cr	Sludge (Liquids)	BL (Liquid)	97 kL	3.93E-3 µg/g	4.31E-4 kg	E	
Cr	Sludge (Solids)	BL (Solid)	548 kL	1.86E+03 µg/g	1.48E+03 kg	S	
Cr	Supernatant	BL (Liquid)	1924 kL	1.36E+01 µg/g	3.01E+01 kg	S	
Cr	**Total**	--	**2569 kL**	--	**1.51E+03 kg**	--	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
F	Sludge (Liquids)	BL (Liquid)	97 kL	1.94E+02 µg/g	2.07E+01 kg	S	
F	Sludge (Solids)	BL (Solid)	548 kL	3.13E+02 µg/g	2.49E+02 kg	S	
F	Supernatant	BL (Liquid)	1924 kL	4.58E+01 µg/g	1.01E+02 kg	S	
F	**Total**	--	**2569 kL**	--	**3.71E+02 kg**	--	Upper bounding estimate
Fe	Sludge (Liquids)	BL (Liquid)	97 kL	4.59E+00 µg/g	4.90E-1 kg	S	
Fe	Sludge (Solids)	BL (Solid)	548 kL	1.09E+05 µg/g	8.69E+04 kg	S	
Fe	Supernatant	BL (Liquid)	1924 kL	7.38E+00 µg/g	1.60E+01 kg	S	
Fe	**Total**	--	**2569 kL**	--	**8.69E+04 kg**	--	
Hg	Sludge (Liquids)	BL (Liquid)	97 kL	0.00E+00 µg/g	0.00E+00 kg	E	
Hg	Sludge (Solids)	BL (Solid)	548 kL	1.39E+02 µg/g	1.13E+02 kg	S	
Hg	Supernatant	BL (Liquid)	1924 kL	2.71E-1 µg/g	5.88E-1 kg	S	
Hg	**Total**	--	**2569 kL**	--	**1.13E+02 kg**	--	Per protocol, sample data overwrites Higley (2000)
K	Sludge (Liquids)	BL (Liquid)	97 kL	5.03E+02 µg/g	5.36E+01 kg	S	
K	Sludge (Solids)	BL (Solid)	548 kL	6.58E+02 µg/g	5.23E+02 kg	S	
K	Supernatant	BL (Liquid)	1924 kL	5.68E+02 µg/g	1.26E+03 kg	S	
K	**Total**	--	**2569 kL**	--	**1.83E+03 kg**	--	.
La	Sludge (Liquids)	BL (Liquid)	97 kL	0.00E+00 µg/g	0.00E+00 kg	E	
La	Sludge (Solids)	BL (Solid)	548 kL	1.42E+03 µg/g	1.12E+03 kg	S	
La	Supernatant	BL (Liquid)	1924 kL	0.00E+00 µg/g	0.00E+00 kg	E	
La	**Total**	--	**2569 kL**	--	**1.12E+03 kg**	--	.
Mn	Sludge (Liquids)	BL (Liquid)	97 kL	0.00E+00 µg/g	0.00E+00 kg	E	
Mn	Sludge (Solids)	BL (Solid)	548 kL	1.45E+04 µg/g	1.15E+04 kg	S	
Mn	Supernatant	BL (Liquid)	1924 kL	0.00E+00 µg/g	0.00E+00 kg	E	
Mn	**Total**	--	**2569 kL**	--	**1.15E+04 kg**	--	.
Na	Sludge (Liquids)	BL (Liquid)	97 kL	3.48E+04 µg/g	3.71E+03 kg	S	
Na	Sludge (Solids)	BL (Solid)	548 kL	6.71E+04 µg/g	5.33E+04 kg	S	
Na	Supernatant	BL (Liquid)	1924 kL	7.98E+04 µg/g	1.83E+05 kg	E	
Na	**Total**	--	**2569 kL**	--	**2.40E+05 kg**	--	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
Ni	Sludge (Liquids)	BL (Liquid)	97 kL	1.84E+00 µg/g	1.96E-1 kg	S	
Ni	Sludge (Solids)	BL (Solid)	548 kL	2.65E+03 µg/g	2.11E+03 kg	S	
Ni	Supernatant	BL (Liquid)	1924 kL	2.57E+00 µg/g	5.60E+00 kg	S	
Ni	**Total**	--	**2569 kL**	--	**2.11E+03 kg**	--	
NO_2	Sludge (Liquids)	BL (Liquid)	97 kL	2.08E+02 µg/g	2.22E+01 kg	S	
NO_2	Sludge (Solids)	BL (Solid)	548 kL	6.50E+01 µg/g	5.16E+01 kg	S	
NO_2	Supernatant	BL (Liquid)	1924 kL	4.21E+04 µg/g	9.64E+04 kg	E	
NO_2	**Total**	--	**2569 kL**	--	**9.65E+04 kg**	--	
NO_3	Sludge (Liquids)	BL (Liquid)	97 kL	2.68E+02 µg/g	2.86E+01 kg	S	
NO_3	Sludge (Solids)	BL (Solid)	548 kL	3.66E+01 µg/g	2.91E+01 kg	S	
NO_3	Supernatant	BL (Liquid)	1924 kL	3.25E+02 µg/g	7.19E+02 kg	S	
NO_3	**Total**	--	**2569 kL**	--	**7.76E+02 kg**	--	.
Pb	Sludge (Liquids)	BL (Liquid)	97 kL	0.00E+00 µg/g	0.00E+00 kg	E	
Pb	Sludge (Solids)	BL (Solid)	548 kL	4.43E+03 µg/g	3.52E+03 kg	S	
Pb	Supernatant	BL (Liquid)	1924 kL	0.00E+00 µg/g	0.00E+00 kg	E	
Pb	**Total**	--	**2569 kL**	--	**3.52E+03 kg**	--	.
PO_4	Sludge (Liquids)	BL (Liquid)	97 kL	9.42E+02 µg/g	1.01E+02 kg	S	
PO_4	Sludge (Solids)	BL (Solid)	548 kL	1.14E+04 µg/g	9.04E+03 kg	S	
PO_4	Supernatant	BL (Liquid)	1924 kL	2.85E+03 µg/g	6.31E+03 kg	S	
PO_4	**Total**	-	**2569 kL**	--	**1.54E+04 kg**	--	.
Si	Sludge (Liquids)	BL (Liquid)	97 kL	6.99E+00 µg/g	7.46E-1 kg	S	
Si	Sludge (Solids)	BL (Solid)	548 kL	1.42E+02 µg/g	1.13E+02 kg	S	
Si	Supernatant	BL (Liquid)	1924 kL	8.48E+01 µg/g	1.88E+02 kg	S	
Si	**Total**	--	**2569 kL**	--	**3.01E+02 kg**	--	
SO_4	Sludge (Liquids)	BL (Liquid)	97 kL	1.09E+03 µg/g	1.16E+02 kg	S	
SO_4	Sludge (Solids)	BL (Solid)	548 kL	1.91E+03 µg/g	1.51E+03 kg	S	
SO_4	Supernatant	BL (Liquid)	1924 kL	1.88E+03 µg/g	4.16E+03 kg	S	
SO_4	**Total**	--	**2569 kL**	--	**5.79E+03 kg**	--	.
Sr	Sludge (Liquids)	BL (Liquid)	97 kL	9.18E-1 µg/g	9.80E-2 kg	S	
Sr	Sludge (Solids)	BL (Solid)	548 kL	2.88E+02 µg/g	2.28E+02 kg	S	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
Sr	Supernatant	BL (Liquid)	1924 kL	1.29E+00 µg/g	2.80E+00 kg	S	
Sr	**Total**	--	**2569 kL**	--	**2.31E+02 kg**	--	.
TOC	Sludge (Liquids)	BL (Liquid)	97 kL	1.93E+03 µg/g	2.06E+02 kg	S	
TOC	Sludge (Solids)	BL (Solid)	548 kL	5.60E+03 µg/g	4.45E+03 kg	S	
TOC	Supernatant	BL (Liquid)	1924 kL	1.30E+03 µg/g	2.88E+03 kg	S	
TOC	**Total**	--	**2569 kL**	--	**7.53E+03 kg**	--	
UTOTAL	Sludge (Liquids)	BL (Liquid)	97 kL	2.59E+03 µg/g	2.76E+02 kg	S	
UTOTAL	Sludge (Solids)	BL (Solid)	548 kL	2.96E+03 µg/g	2.35E+03 kg	S	
UTOTAL	Supernatant	BL (Liquid)	1924 kL	1.64E+02 µg/g	3.62E+02 kg	S	
UTOTAL	**Total**	--	**2569 kL**	--	**2.99E+03 kg**	--	
Zr	Sludge (Liquids)	BL (Liquid)	97 kL	2.74E+00 µg/g	2.92E-1 kg	S	
Zr	Sludge (Solids)	BL (Solid)	548 kL	3.60E+01 µg/g	2.86E+01 kg	S	
Zr	Supernatant	BL (Liquid)	1924 kL	1.29E+00 µg/g	2.80E+00 kg	S	
Zr	**Total**	--	**2569 kL**	--	**3.17E+01 kg**	--	.
^{3}H	Sludge (Liquids)	BL (Liquid)	97 kL	6.30E-3 µCi/g	6.91E-1 Ci	E	
^{3}H	Sludge (Solids)	BL (Solid)	548 kL	9.01E-3 µCi/g	7.31E+00 Ci	S	
^{3}H	Supernatant	BL (Liquid)	1924 kL	5.80E-3 µCi/g	1.26E+01 Ci	S	
^{3}H	**Total**	--	**2569 kL**	--	**2.06E+01 Ci**	--	
^{14}C	Sludge (Liquids)	BL (Liquid)	97 kL	6.27E-4 µCi/g	6.87E-2 Ci	E	
^{14}C	Sludge (Solids)	BL (Solid)	548 kL	2.15E-4 µCi/g	1.74E-1 Ci	S	
^{14}C	Supernatant	BL (Liquid)	1924 kL	2.03E-4 µCi/g	4.41E-1 Ci	S	
^{14}C	**Total**	--	**2569 kL**	--	**6.84E-1 Ci**	--	.
^{59}Ni	Sludge (Liquids)	BL (Liquid)	97 kL	1.07E-4 µCi/g	1.17E-2 Ci	E	
^{59}Ni	Sludge (Solids)	BL (Solid)	548 kL	1.24E-1 µCi/g	1.10E+02 Ci	E	
^{59}Ni	Supernatant	BL (Liquid)	1924 kL	2.15E-4 µCi/g	4.68E-1 Ci	E	
^{59}Ni	**Total**	--	**2569 kL**	--	**1.11E+02 Ci**	--	
^{60}Co	Sludge (Liquids)	BL (Liquid)	97 kL	5.64E-4 µCi/g	6.18E-2 Ci	E	
^{60}Co	Sludge (Solids)	BL (Solid)	548 kL	6.54E-4 µCi/g	5.81E-1 Ci	E	
^{60}Co	Supernatant	BL (Liquid)	1924 kL	4.78E-3 µCi/g	1.04E+01 Ci	S	
^{60}Co	**Total**	--	**2569 kL**	--	**1.10E+01 Ci**	--	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{63}Ni	Sludge (Liquids)	BL (Liquid)	97 kL	1.00E-2 µCi/g	1.10E+00 Ci	E	
^{63}Ni	Sludge (Solids)	BL (Solid)	548 kL	1.17E+01 µCi/g	1.04E+04 Ci	E	
^{63}Ni	Supernatant	BL (Liquid)	1924 kL	2.02E-2 µCi/g	4.39E+01 Ci	E	
^{63}Ni	**Total**	--	**2569 kL**	--	**1.04E+04 Ci**	--	
^{79}Se	Sludge (Liquids)	BL (Liquid)	97 kL	4.27E-5 µCi/g	4.68E-3 Ci	E	
^{79}Se	Sludge (Solids)	BL (Solid)	548 kL	4.95E-5 µCi/g	4.39E-2 Ci	E	
^{79}Se	Supernatant	BL (Liquid)	1924 kL	4.51E-5 µCi/g	9.80E-2 Ci	S	
^{79}Se	**Total**	--	**2569 kL**	--	**1.47E-1 Ci**	--	.
^{90}Sr	Sludge (Liquids)	BL (Liquid)	97 kL	1.09E+01 µCi/g	1.19E+03 Ci	E	
^{90}Sr	Sludge (Solids)	BL (Solid)	548 kL	6.50E+03 µCi/g	5.27E+06 Ci	S	
^{90}Sr	Supernatant	BL (Liquid)	1924 kL	1.42E+00 µCi/g	3.08E+03 Ci	S	
^{90}Sr	**Total**	--	**2569 kL**	--	**5.28E+06 Ci**	--	
^{90}Y	Sludge (Liquids)	BL (Liquid)	97 kL	1.09E+01 µCi/g	1.19E+03 Ci	C	
^{90}Y	Sludge (Solids)	BL (Solid)	548 kL	6.50E+03 µCi/g	5.27E+06 Ci	C	
^{90}Y	Supernatant	BL (Liquid)	1924 kL	1.42E+00 µCi/g	3.08E+03 Ci	C	
^{90}Y	**Total**	--	**2569 kL**	--	**5.28E+06 Ci**	--	Based on ^{90}Sr
^{93}Zr	Sludge (Liquids)	BL (Liquid)	97 kL	1.92E-3 µCi/g	2.10E-1 Ci	E	
^{93}Zr	Sludge (Solids)	BL (Solid)	548 kL	2.23E-3 µCi/g	1.98E+00 Ci	E	
^{93}Zr	Supernatant	BL (Liquid)	1924 kL	3.88E-3 µCi/g	8.43E+00 Ci	E	
^{93}Zr	**Total**	--	**2569 kL**	--	**1.06E+01 Ci**	--	
^{93m}Nb	Sludge (Liquids)	BL (Liquid)	97 kL	1.65E-3 µCi/g	1.81E-1 Ci	E	
^{93m}Nb	Sludge (Solids)	BL (Solid)	548 kL	1.91E-3 µCi/g	1.70E+00 Ci	E	
^{93m}Nb	Supernatant	BL (Liquid)	1924 kL	3.34E-3 µCi/g	7.26E+00 Ci	E	
^{93m}Nb	**Total**	--	**2569 kL**	--	**9.14E+00 Ci**	--	
^{99}Tc	Sludge (Liquids)	BL (Liquid)	97 kL	4.19E-3 µCi/g	4.60E-1 Ci	E	
^{99}Tc	Sludge (Solids)	BL (Solid)	548 kL	1.72E-2 µCi/g	1.39E+01 Ci	S	
^{99}Tc	Supernatant	BL (Liquid)	1924 kL	8.71E-3 µCi/g	1.89E+01 Ci	S	
^{99}Tc	**Total**	--	**2569 kL**	--	**3.33E+01 Ci**	--	.
^{106}Ru	Sludge (Liquids)	BL (Liquid)	97 kL	1.53E-8 µCi/g	1.68E-6 Ci	E	
^{106}Ru	Sludge (Solids)	BL (Solid)	548 kL	8.49E-6 µCi/g	7.54E-3 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{106}Ru	Supernatant	BL (Liquid)	1924 kL	3.10E-8 µCi/g	6.74E-5 Ci	E	
^{106}Ru	**Total**	--	**2569 kL**	--	**7.61E-3 Ci**	--	
^{113m}Cd	Sludge (Liquids)	BL (Liquid)	97 kL	4.69E-3 µCi/g	5.14E-1 Ci	E	
^{113m}Cd	Sludge (Solids)	BL (Solid)	548 kL	5.44E-3 µCi/g	4.83E+00 Ci	E	
^{113m}Cd	Supernatant	BL (Liquid)	1924 kL	9.47E-3 µCi/g	2.06E+01 Ci	E	
^{113m}Cd	**Total**	--	**2569 kL**	--	**2.59E+01 Ci**	--	
^{125}Sb	Sludge (Liquids)	BL (Liquid)	97 kL	1.50E-3 µCi/g	1.65E-1 Ci	E	
^{125}Sb	Sludge (Solids)	BL (Solid)	548 kL	1.74E-3 µCi/g	1.55E+00 Ci	E	
^{125}Sb	Supernatant	BL (Liquid)	1924 kL	3.03E-3 µCi/g	6.59E+00 Ci	E	
^{125}Sb	**Total**	--	**2569 kL**	--	**8.31E+00 Ci**	--	
^{126}Sn	Sludge (Liquids)	BL (Liquid)	97 kL	2.69E-4 µCi/g	2.95E-2 Ci	E	
^{126}Sn	Sludge (Solids)	BL (Solid)	548 kL	3.13E-4 µCi/g	2.78E-1 Ci	E	
^{126}Sn	Supernatant	BL (Liquid)	1924 kL	5.44E-4 µCi/g	1.18E+00 Ci	E	
^{126}Sn	**Total**	--	**2569 kL**	--	**1.49E+00 Ci**	--	
^{129}I	Sludge (Liquids)	BL (Liquid)	97 kL	8.20E-6 µCi/g	8.99E-4 Ci	E	
^{129}I	Sludge (Solids)	BL (Solid)	548 kL	9.50E-6 µCi/g	8.43E-3 Ci	E	
^{129}I	Supernatant	BL (Liquid)	1924 kL	1.66E-5 µCi/g	3.60E-2 Ci	E	
^{129}I	**Total**	--	**2569 kL**	--	**4.54E-2 Ci**	--	
^{134}Cs	Sludge (Liquids)	BL (Liquid)	97 kL	0.00E+00 µCi/g	0.00E+00 Ci	E	
^{134}Cs	Sludge (Solids)	BL (Solid)	548 kL	2.63E-1 µCi/g	2.14E+02 Ci	S	
^{134}Cs	Supernatant	BL (Liquid)	1924 kL	0.00E+00 µCi/g	0.00E+00 Ci	E	
^{134}Cs	**Total**	--	**2569 kL**	--	**2.14E+02 Ci**	--	Upper bounding estimate
^{137}Cs	Sludge (Liquids)	BL (Liquid)	97 kL	0.00E+00 µCi/g	0.00E+00 Ci	E	
^{137}Cs	Sludge (Solids)	BL (Solid)	548 kL	1.99E+02 µCi/g	1.61E+05 Ci	S	
^{137}Cs	Supernatant	BL (Liquid)	1924 kL	2.55E+01 µCi/g	5.53E+04 Ci	S	
^{137}Cs	**Total**	--	**2569 kL**	--	**2.17E+05 Ci**	--	
^{137m}Ba	Sludge (Liquids)	BL (Liquid)	97 kL	0.00E+00 µCi/g	0.00E+00 Ci	C	
^{137m}Ba	Sludge (Solids)	BL (Solid)	548 kL	1.88E+02 µCi/g	1.53E+05 Ci	C	
^{137m}Ba	Supernatant	BL (Liquid)	1924 kL	2.41E+01 µCi/g	5.23E+04 Ci	C	
^{137m}Ba	**Total**	--	**2569 kL**	--	**2.05E+05 Ci**	--	Based on ^{137}Cs

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{151}Sm	Sludge (Liquids)	BL (Liquid)	97 kL	1.46E+00 µCi/g	1.61E+02 Ci	E	
^{151}Sm	Sludge (Solids)	BL (Solid)	548 kL	1.70E+00 µCi/g	1.51E+03 Ci	E	
^{151}Sm	Supernatant	BL (Liquid)	1924 kL	2.96E+00 µCi/g	6.43E+03 Ci	E	
^{151}Sm	**Total**	--	**2569 kL**	--	**8.10E+03 Ci**	--	
^{152}Eu	Sludge (Liquids)	BL (Liquid)	97 kL	2.70E-4 µCi/g	2.96E-2 Ci	E	
^{152}Eu	Sludge (Solids)	BL (Solid)	548 kL	6.91E-2 µCi/g	6.13E+01 Ci	E	
^{152}Eu	Supernatant	BL (Liquid)	1924 kL	5.45E-4 µCi/g	1.19E+00 Ci	E	
^{152}Eu	**Total**	--	**2569 kL**	--	**6.25E+01 Ci**	--	
^{154}Eu	Sludge (Liquids)	BL (Liquid)	97 kL	2.43E-2 µCi/g	2.66E+00 Ci	E	
^{154}Eu	Sludge (Solids)	BL (Solid)	548 kL	8.35E+00 µCi/g	6.77E+03 Ci	S	
^{154}Eu	Supernatant	BL (Liquid)	1924 kL	1.33E-2 µCi/g	2.88E+01 Ci	S	
^{154}Eu	**Total**	--	**2569 kL**	--	**6.80E+03 Ci**	--	
^{155}Eu	Sludge (Liquids)	BL (Liquid)	97 kL	8.31E-3 µCi/g	9.11E-1 Ci	E	
^{155}Eu	Sludge (Solids)	BL (Solid)	548 kL	6.82E+00 µCi/g	5.53E+03 Ci	S	
^{155}Eu	Supernatant	BL (Liquid)	1924 kL	8.07E-3 µCi/g	1.77E+01 Ci	E	
^{155}Eu	**Total**	--	**2569 kL**	--	**5.55E+03 Ci**	--	
^{226}Ra	Sludge (Liquids)	BL (Liquid)	97 kL	2.34E-8 µCi/g	2.56E-6 Ci	E	
^{226}Ra	Sludge (Solids)	BL (Solid)	548 kL	4.12E-6 µCi/g	3.66E-3 Ci	E	
^{226}Ra	Supernatant	BL (Liquid)	1924 kL	4.72E-8 µCi/g	1.03E-4 Ci	E	
^{226}Ra	**Total**	--	**2569 kL**	--	**3.76E-3 Ci**	--	
^{227}Ac	Sludge (Liquids)	BL (Liquid)	97 kL	1.84E-7 µCi/g	2.02E-5 Ci	E	
^{227}Ac	Sludge (Solids)	BL (Solid)	548 kL	1.45E-5 µCi/g	1.29E-2 Ci	E	
^{227}Ac	Supernatant	BL (Liquid)	1924 kL	3.73E-7 µCi/g	8.10E-4 Ci	E	
^{227}Ac	**Total**	--	**2569 kL**	--	**1.37E-2 Ci**	--	
^{228}Ra	Sludge (Liquids)	BL (Liquid)	97 kL	2.29E-13 µCi/g	2.51E-11 Ci	E	
^{228}Ra	Sludge (Solids)	BL (Solid)	548 kL	3.85E-5 µCi/g	3.42E-2 Ci	E	
^{228}Ra	Supernatant	BL (Liquid)	1924 kL	4.63E-13 µCi/g	1.01E-9 Ci	E	
^{228}Ra	**Total**	--	**2569 kL**	--	**3.42E-2 Ci**	--	
^{229}Th	Sludge (Liquids)	BL (Liquid)	97 kL	3.05E-11 µCi/g	3.34E-9 Ci	E	
^{229}Th	Sludge (Solids)	BL (Solid)	548 kL	7.81E-9 µCi/g	6.93E-6 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{229}Th	Supernatant	BL (Liquid)	1924 kL	6.17E-11 µCi/g	1.34E-7 Ci	E	
^{229}Th	**Total**	--	**2569 kL**	--	**7.07E-6 Ci**	--	
^{231}Pa	Sludge (Liquids)	BL (Liquid)	97 kL	3.78E-7 µCi/g	4.14E-5 Ci	E	
^{231}Pa	Sludge (Solids)	BL (Solid)	548 kL	4.40E-7 µCi/g	3.90E-4 Ci	E	
^{231}Pa	Supernatant	BL (Liquid)	1924 kL	7.64E-7 µCi/g	1.66E-3 Ci	E	
^{231}Pa	**Total**	--	**2569 kL**	--	**2.09E-3 Ci**	--	
^{232}Th	Sludge (Liquids)	BL (Liquid)	97 kL	2.52E-13 µCi/g	2.76E-11 Ci	E	
^{232}Th	Sludge (Solids)	BL (Solid)	548 kL	7.04E-5 µCi/g	6.02E-2 Ci	S	
^{232}Th	Supernatant	BL (Liquid)	1924 kL	5.09E-13 µCi/g	1.11E-9 Ci	E	
^{232}Th	**Total**	--	**2569 kL**	--	**6.02E-2 Ci**	--	
^{232}U	Sludge (Liquids)	BL (Liquid)	97 kL	2.78E-7 µCi/g	2.97E-5 Ci	E	
^{232}U	Sludge (Solids)	BL (Solid)	548 kL	3.14E-7 µCi/g	2.55E-4 Ci	E	
^{232}U	Supernatant	BL (Liquid)	1924 kL	1.77E-8 µCi/g	3.92E-5 Ci	E	
^{232}U	**Total**	--	**2569 kL**	--	**3.24E-4 Ci**	--	Based on UTOTAL and Template isotopic Distribution
^{233}U	Sludge (Liquids)	BL (Liquid)	97 kL	4.02E-9 µCi/g	4.29E-7 Ci	E	
^{233}U	Sludge (Solids)	BL (Solid)	548 kL	4.59E-9 µCi/g	3.72E-6 Ci	E	
^{233}U	Supernatant	BL (Liquid)	1924 kL	2.58E-10 µCi/g	5.71E-7 Ci	E	
^{233}U	**Total**	--	**2569 kL**	--	**4.72E-6 Ci**	--	Based on UTOTAL and Template isotopic Distribution
^{234}U	Sludge (Liquids)	BL (Liquid)	97 kL	1.12E-3 µCi/g	1.19E-1 Ci	E	
^{234}U	Sludge (Solids)	BL (Solid)	548 kL	1.28E-3 µCi/g	1.04E+00 Ci	E	
^{234}U	Supernatant	BL (Liquid)	1924 kL	7.21E-5 µCi/g	1.59E-1 Ci	E	
^{234}U	**Total**	--	**2569 kL**	--	**1.32E+00 Ci**	--	Based on UTOTAL and Template isotopic Distribution
^{235}U	Sludge (Liquids)	BL (Liquid)	97 kL	4.34E-5 µCi/g	4.63E-3 Ci	E	
^{235}U	Sludge (Solids)	BL (Solid)	548 kL	4.95E-5 µCi/g	4.01E-2 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{235}U	Supernatant	BL (Liquid)	1924 kL	2.79E-6 µCi/g	6.17E-3 Ci	E	
^{235}U	**Total**	--	**2569 kL**	--	**5.09E-2 Ci**	--	Based on UTOTAL and Template isotopic Distribution
^{236}U	Sludge (Liquids)	BL (Liquid)	97 kL	8.15E-5 µCi/g	8.69E-3 Ci	E	
^{236}U	Sludge (Solids)	BL (Solid)	548 kL	9.31E-5 µCi/g	7.55E-2 Ci	E	
^{236}U	Supernatant	BL (Liquid)	1924 kL	5.24E-6 µCi/g	1.16E-2 Ci	E	
^{236}U	**Total**	--	**2569 kL**	--	**9.58E-2 Ci**	--	Based on UTOTAL and Template isotopic Distribution
^{237}Np	Sludge (Liquids)	BL (Liquid)	97 kL	1.35E-5 µCi/g	1.47E-3 Ci	E	
^{237}Np	Sludge (Solids)	BL (Solid)	548 kL	4.62E-3 µCi/g	3.95E+00 Ci	S	
^{237}Np	Supernatant	BL (Liquid)	1924 kL	3.99E-4 µCi/g	8.68E-1 Ci	S	
^{237}Np	**Total**	--	**2569 kL**	--	**4.82E+00 Ci**	--	
^{238}Pu	Sludge (Liquids)	BL (Liquid)	97 kL	1.77E-4 µCi/g	1.94E-2 Ci	E	
^{238}Pu	Sludge (Solids)	BL (Solid)	548 kL	6.48E-1 µCi/g	5.26E+02 Ci	S	
^{238}Pu	Supernatant	BL (Liquid)	1924 kL	3.25E-4 µCi/g	7.12E-1 Ci	S	
^{238}Pu	**Total**	--	**2569 kL**	--	**5.27E+02 Ci**		Sludge solids and supernatant from Sample ^{238}Pu, Sludge liquid from template
^{238}U	Sludge (Liquids)	BL (Liquid)	97 kL	8.64E-4 µCi/g	9.22E-2 Ci	E	
^{238}U	Sludge (Solids)	BL (Solid)	548 kL	9.87E-4 µCi/g	8.00E-1 Ci	E	
^{238}U	Supernatant	BL (Liquid)	1924 kL	5.56E-5 µCi/g	1.23E-1 Ci	E	
^{238}U	**Total**	--	**2569 kL**	--	**1.02E+00 Ci**	--	Based on UTOTAL and Template isotopic Distribution
^{239}Pu	Sludge (Liquids)	BL (Liquid)	97 kL	3.27E-3 µCi/g	3.59E-1 Ci	E	
^{239}Pu	Sludge (Solids)	BL (Solid)	548 kL	2.02E+00 µCi/g	1.64E+03 Ci	E	
^{239}Pu	Supernatant	BL (Liquid)	1924 kL	1.85E-3 µCi/g	4.06E+00 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{239}Pu	**Total**	--	**2569 kL**	--	**1.64E+03 Ci**	--	Sludge solids and supernatant based on $^{239/240}$Pu and Template isotopic distribution, Sludge liquid from template
^{240}Pu	Sludge (Liquids)	BL (Liquid)	97 kL	7.10E-4 µCi/g	7.78E-2 Ci	E	
^{240}Pu	Sludge (Solids)	BL (Solid)	548 kL	4.38E-1 µCi/g	3.55E+02 Ci	E	
^{240}Pu	Supernatant	BL (Liquid)	1924 kL	4.01E-4 µCi/g	8.80E-1 Ci	E	
^{240}Pu	**Total**	--	**2569 kL**	--	**3.56E+02 Ci**	--	Sludge solids and supernatant based on $^{239/240}$Pu and Template isotopic distribution, Sludge liquid from template
^{241}Am	Sludge (Liquids)	BL (Liquid)	97 kL	1.13E-2 µCi/g	1.24E+00 Ci	E	
^{241}Am	Sludge (Solids)	BL (Solid)	548 kL	9.40E+00 µCi/g	7.62E+03 Ci	E	
^{241}Am	Supernatant	BL (Liquid)	1924 kL	2.20E-4 µCi/g	4.83E-1 Ci	E	
^{241}Am	**Total**	--	**2569 kL**	--	**7.62E+03 Ci**	--	Sludge solids and supernatant from Sample ^{241}Am, Sludge liquid from template
^{241}Pu	Sludge (Liquids)	BL (Liquid)	97 kL	9.33E-3 µCi/g	1.02E+00 Ci	E	
^{241}Pu	Sludge (Solids)	BL (Solid)	548 kL	5.45E+00 µCi/g	4.42E+03 Ci	E	
^{241}Pu	Supernatant	BL (Liquid)	1924 kL	5.09E-3 µCi/g	1.12E+01 Ci	E	
^{241}Pu	**Total**	--	**2569 kL**	--	**4.44E+03 Ci**	--	Sludge solids and supernatant based on ^{239}Pu and Template isotopic distribution, Sludge liquid from template
^{242}Cm	Sludge (Liquids)	BL (Liquid)	97 kL	1.98E-5 µCi/g	2.17E-3 Ci	E	
^{242}Cm	Sludge (Solids)	BL (Solid)	548 kL	1.72E-2 µCi/g	1.40E+01 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{242}Cm	Supernatant	BL (Liquid)	1924 kL	3.77E-7 µCi/g	8.27E-4 Ci	E	
^{242}Cm	**Total**	--	**2569 kL**	--	**1.40E+01 Ci**	--	Sludge solids and supernatant based on ^{241}Am and Template isotopic distribution, Sludge liquid from template
^{242}Pu	Sludge (Liquids)	BL (Liquid)	97 kL	8.50E-8 µCi/g	9.32E-6 Ci	E	
^{242}Pu	Sludge (Solids)	BL (Solid)	548 kL	5.26E-5 µCi/g	4.27E-2 Ci	E	
^{242}Pu	Supernatant	BL (Liquid)	1924 kL	4.82E-8 µCi/g	1.06E-4 Ci	E	
^{242}Pu	**Total**	--	**2569 kL**	--	**4.28E-2 Ci**	--	Sludge solids and supernatant based on ^{239}Pu and Template isotopic distribution, Sludge liquid from template
^{243}Am	Sludge (Liquids)	BL (Liquid)	97 kL	8.57E-7 µCi/g	9.40E-5 Ci	E	
^{243}Am	Sludge (Solids)	BL (Solid)	548 kL	6.91E-4 µCi/g	5.60E-1 Ci	E	
^{243}Am	Supernatant	BL (Liquid)	1924 kL	1.63E-8 µCi/g	3.58E-5 Ci	E	
^{243}Am	**Total**	--	**2569 kL**	--	**5.61E-1 Ci**	--	Sludge solids and supernatant based on ^{241}Am and Template isotopic distribution, Sludge liquid from template
^{243}Cm	Sludge (Liquids)	BL (Liquid)	97 kL	1.84E-6 µCi/g	2.02E-4 Ci	E	
^{243}Cm	Sludge (Solids)	BL (Solid)	548 kL	1.57E-3 µCi/g	1.27E+00 Ci	E	
^{243}Cm	Supernatant	BL (Liquid)	1924 kL	3.45E-8 µCi/g	7.57E-5 Ci	E	
^{243}Cm	**Total**	--	**2569 kL**	--	**1.27E+00 Ci**	--	Sludge solids and supernatant based on ^{241}Am and Template isotopic distribution, Sludge liquid from template
^{244}Cm	Sludge (Liquids)	BL (Liquid)	97 kL	2.89E-5 µCi/g	3.17E-3 Ci	E	

Analyte	Waste phase	Waste type	Volume	Concentration	Inventory	Basis	Comment
^{244}Cm	Sludge (Solids)	BL (Solid)	548 kL	3.73E-2 µCi/g	3.03E+01 Ci	E	
^{244}Cm	Supernatant	BL (Liquid)	1924 kL	5.35E-7 µCi/g	1.17E-3 Ci	E	
^{244}Cm	**Total**	--	**2569 kL**	--	**1.17E-3 Ci**	--	Sludge solids and supernatant based on ^{241}Am and Template isotopic distribution, Sludge liquid from template

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