FEB 15 1995
Sta. 21 (20)

ENGINEERING DATA TRANSMITTAL

1. EDT № 611538

2. To: (Receiving Organization) Pretreatment Program Office	3. From: (Originating Organization) Process Design	4. Related EDT No.:
5. Proj./Prog./Dept./Div.: Project W-236B/TWRS	6. Cog. Engr.: L.M. Swanson/A.F. Johnke	7. Purchase Order No.:
8. Originator Remarks: The attached Preliminary Design Requirements Document establishes the design requirements for Project W-236B, Initial Pretreatment Module and replaces the Functions and Requirements for Projects W236B, Initial Pretreatment Module, WHC-SD-W236B-FRD-002, Rev. 1, September 1994. This document is issued with impact level N/A per the milestone description sheet (T3A-95-145). Additional WHC approvals and DOE comment and approval will follow in a separate transmittal.		9. Equip./Component No.: NA 10. System/Bldg./Facility: Disposal Engineering
11. Receiver Remarks: RECEIVED MAR 09 1995 OSTI		12. Major Assm. Dwg. No.: NA 13. Permit/Permit Application No.: NA 14. Required Response Date: NA

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-W236B-DRD-001		0	Preliminary Design Requirements Document for Project W-236B, Initial Pretreatment Module	NA	1	1	

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
1	/	Cog.Eng. L.M. Swanson	L.M. Swanson		H5-49	Central Files (2)			L8-04	3	
1	/	Cog. Mgr. J.S. Garfield	J S Garfield		H5-49	OSTI (2)			L8-07	3	
3	/	I. E. Reep	I E Reep		G3-21	SK Baker			H5-70	3	
3	/	K. A. Gasper	KA Gasper		G3-21	KD Boomer			H5-49	3	
3		R. R. Gadd			G3-20	JA Swenson			H5-49	3	

18.	19.	20.	21. DOE APPROVAL (if required) Ctrl. No.
L.M. Swanson Lynn M. Swanson 2-14-95 Signature of EDT Originator Date	K.A. Gasper K A Gasper 2-15-95 Authorized Representative for Receiving Organization Date	J.S. Garfield J S Garfield 2/14/95 Cognizant Manager Date	[] Approved [] Approved w/comments [] Disapproved w/comments

RELEASE AUTHORIZATION

Document Number:	WHC-SD-W236B-DRD-001 Rev. 0
Document Title:	Preliminary Design Requirements Document (DRD) for Project W-236B, "Initial Pretreatment Module"
Release Date:	February 15, 1995

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Kara M. Broz — February 15, 1995

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy. Available in paper copy and microfiche. Printed in the United States of America. Available to the U.S. Department of Energy and its contractors from:

U.S. Department of Energy
Office of Scientific and Technical Information (OSTI)
P.O. Box 62
Oak Ridge, TN 37831
Telephone: (615) 576-8401

Available to the public from:

U.S. Department of Commerce
National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 487-4650

A-6001-400.2 (09/94) WEF256

SUPPORTING DOCUMENT

1. Total Pages	~~100~~ 101

2. Title	3. Number	4. Rev No.
Preliminary Design Requirements Document (DRD) for Project W-236B, "Initial Pretreatment Module"	WHC-SD-W236B-DRD-001	0

5. Key Words	6. Author
Pretreat Supernatants, IPM Design Requirements Document, DRD, Systems Engineering, Functions and Requirements	Name: L. M. Swanson L. M. Swanson Signature Organization/Charge Code 71220 / D3021

7. Abstract

The attached Preliminary Design Requirements Document (DRD) for Project W-236B implements the WHC systems engineering approach to identify and define the functions, with associated requirements, which must be performed to accomplish pretreatment of retrieved tank waste supernatants. This document represents the baseline scope of the Initial Pretreatment Module. The format for this DRD was defined by systems engineering on January 20, 1995 and is a modified version of the Military Standard 490 System Specification. Due to the document format change, Revision 1 of the IPM Functions and Requirements (F&R) document will be replaced by this DRD, rather than issuing Revision 2 of the IPM F&R. Additional WHC approvals and a DOE-RL comment and approval cycle will be initiated.

8. RELEASE STAMP

OFFICIAL RELEASE BY WHC
DATE FEB 15 1995
Sta. 21

WHC-SD-W236B-DRD-001
Revision 0

PRELIMINARY DESIGN REQUIREMENTS DOCUMENT FOR PROJECT W-236B, INITIAL PRETREATMENT MODULE

February 1995

Westinghouse Hanford Company
Richland, Washington

DISCLAIMER

ACKNOWLEDGEMENTS

Fluor Daniel/WasteChem
Pat Grant

Westinghouse Hanford Company
Al Boldt
Kayle Boomer
Andrew Johnke
Mike Johnson
Carole Leach
Garr Norman
Bill Peiffer
Louis Shelton
Lynn Swanson

Raytheon/BNFL
Stewart Mackay
Milton Williams

1. Infrastructure and Support Systems: Pat Grant, Carole Leach, Bill Peiffer
2. Maintenance and Operations: Carole Leach, Bill Peiffer
3. Processing Performance Requirements: Al Boldt, Stewart Mackay, Mike Johnson, Louis Shelton
4. System Engineering: Mike Johnson, Garr Norman, Milton Williams
5. Lead Author: Lynn Swanson

CONTENTS

LIST OF FIGURES

LIST OF TABLES

PRELIMINARY DESIGN REQUIREMENTS DOCUMENT FOR PROJECT W-236B, INITIAL PRETREATMENT MODULE

1.0 SCOPE

The scope of this Design Requirements Document (DRD) is to identify and define the functions, with associated requirements, which must be performed to separate Hanford Site tank waste supernatants into low-level and high-level fractions. This document sets forth function requirements, performance requirements, and design constraints necessary to begin conceptual design for the Initial Pretreatment Module (IPM). System and physical interfaces between the IPM project and the Tank Waste Remediation System (TWRS) are identified. The constraints, performance requirements, and transfer of information and data across a technical interface will be documented in an Interface Control Document. Supplemental DRDs will be prepared to provide more detailed requirements specific to systems described in the DRD.

1.1 IDENTIFICATION

Program: TWRS

Project: IPM (Project W236-B)
U.S. Department of Energy (DOE) Line Item 94A-EWW-236B

Mission: The mission of the IPM project is to process the retrieved tank waste supernatants (and sludge wash waters) into low-level (LLW) and high-level waste (HLW) fractions.

1.2 SYSTEM OVERVIEW

The *Hanford Mission Plan, Volume 1, Site Guidance* (DOE/RL 1994) states "The Hanford mission is to clean up the Hanford Site, provide scientific and technological excellence to meet global needs, and to partner in the economic diversification of the region." As part of the Hanford Site mission, the TWRS program identifies the need to store, treat, and immobilize the highly radioactive Hanford Site tank wastes and encapsulated cesium and strontium materials in an environmentally sound, safe, and cost effective manner.

The *Hanford Federal Facility Agreement and Compliance Order* (Tri-Party Agreement) specifies milestones for the IPM as shown in Table 1-1. The Tri-Party Agreement specifies completion of retrieval of all waste from SSTs by September 2018 (milestone M-45-05). To minimize construction of additional double-shell storage tanks, the supernatant pretreatment process must operate at a capacity which achieves compliance with the Tri-Party Agreement commitment to complete retrieval of SST wastes. Completion of tank waste supernatant pretreatment will be achieved earlier than the date provided by milestone M-50-00.

Table 1-1. Selected Tri-Party Agreement Milestones.

Milestone number	Title	Date
M-50-00	Complete pretreatment processing of Hanford tank waste.	December 2028
M-50-01-T02	Submit Conceptual Design and Initiate Definitive Design of LLW Pretreatment Facility	December 1996
M-50-02	Start hot operations of LLW Pretreatment Facility to remove cesium and strontium.	December 2004
/M-50-02-T01	Complete construction of LLW Pretreatment Facility.	December 2003
M-50-03	Complete evaluation of enhanced sludge washing to determine whether advanced sludge separation processes are required.	March 1998

LLW = Low-level waste.

A systems engineering process is being applied to the Hanford Site and is being implemented by the TWRS to establish the functions and requirements necessary for accomplishing the TWRS mission. The initial TWRS technical baseline has been established through four levels of functional decomposition and documented in the *Tank Waste Remediation System Functions and Requirements* (DOE 1994b). The Program requirements to implement the Systems Engineering at the Hanford Site are defined in *Fiscal Year 1995 Hanford Mission Plan* (DOE 1994a). The policy and guidance for application of systems engineering throughout the TWRS Program is described in the *Tank Waste Remediation System (TWRS) Systems Engineering Management Plan* (DOE 1994c, Annex 2).

The development of the functions that form the basis for the IPM project have been provided through continuation of the systems engineering process from the top-level system requirements. Figure 1-1 shows the results of the TWRS systems engineering functional hierarchy to the fourth level. Also, the fifth level functions allocated to the IPM from the *Tank Waste Remediation System Technical Requirements Specification* (TRS) (DOE 1991) are provided in Figure 1-1. DOE/RL approval of the TRS is expected by June 1995.

Figure 1-1. Tank Waste Remediation System Systems Engineering Functional Hierarchy.

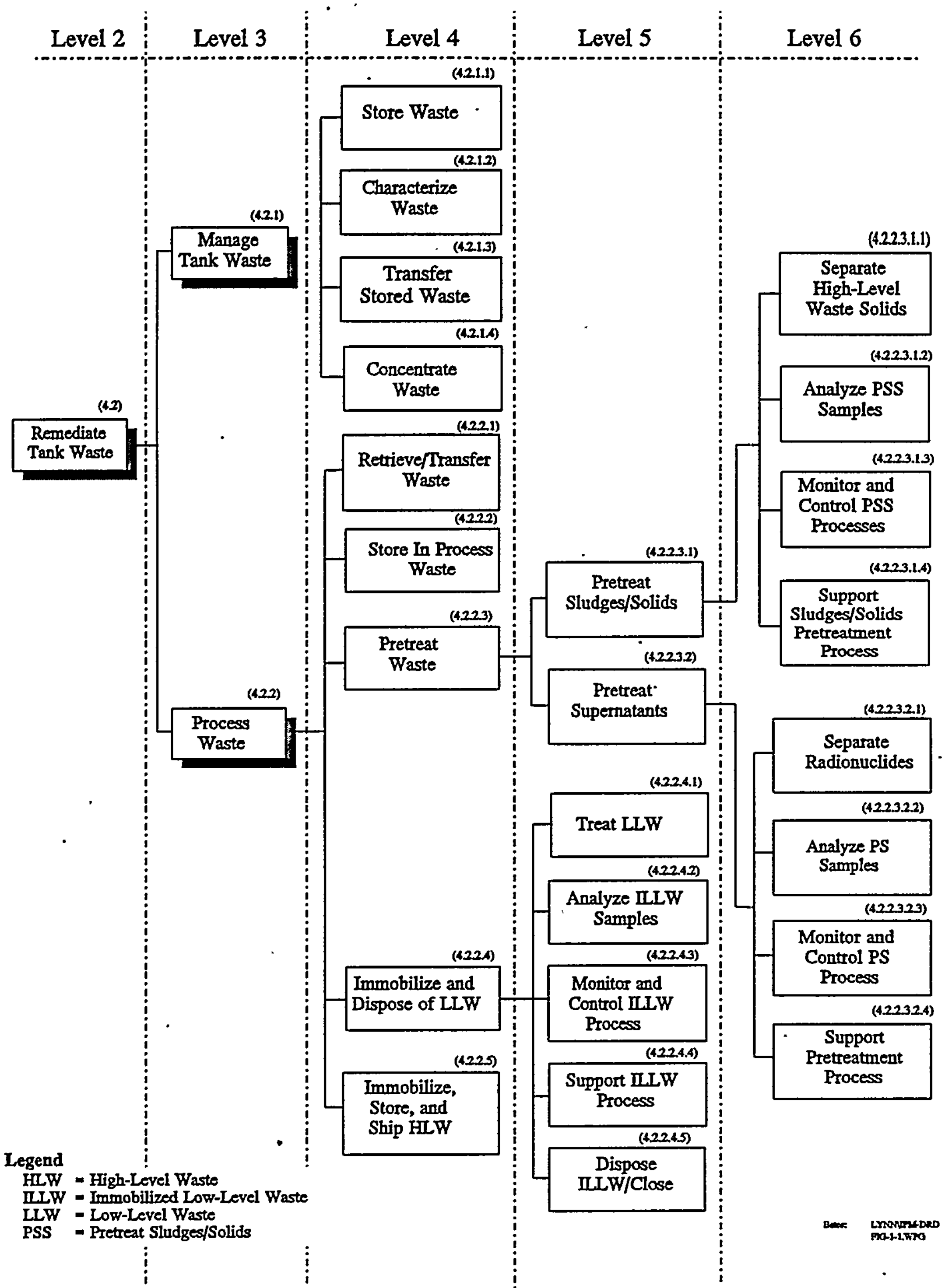


Figure 1-2 illustrates the decomposition of TWRS functions and identifies the documents containing these functions. Function levels 0 and 1 address the entire Hanford site, while level 2 (function 4.2) is specific to the TWRS Program. The *Tank Waste Remediation System Functions and Requirements* (DOE 1994b) contains TWRS Program unique functions from level 2 to level 4. From the *Tank Waste Remediation System Functions and Requirements*, the TRS document begins at level 4 and continues decomposing functions to levels that are sufficient for defining projects. For the IPM Project, the TRS includes level 5 and 6 functions. (The TRS may contain lower levels for other projects.)

Following the allocation of specific TRS functions to a project, a DRD is produced. This document is the DRD for the IPM Project, and DRDs accomplish several purposes. First, they contain the functions and requirements for a single project in a single document, for convenience. Also, TRS project data are organized into an easily readable specification format. Finally, TRS project data are expanded and explained to a degree suitable for providing direction to a project Architect-Engineer.

1.3 DOCUMENT OVERVIEW

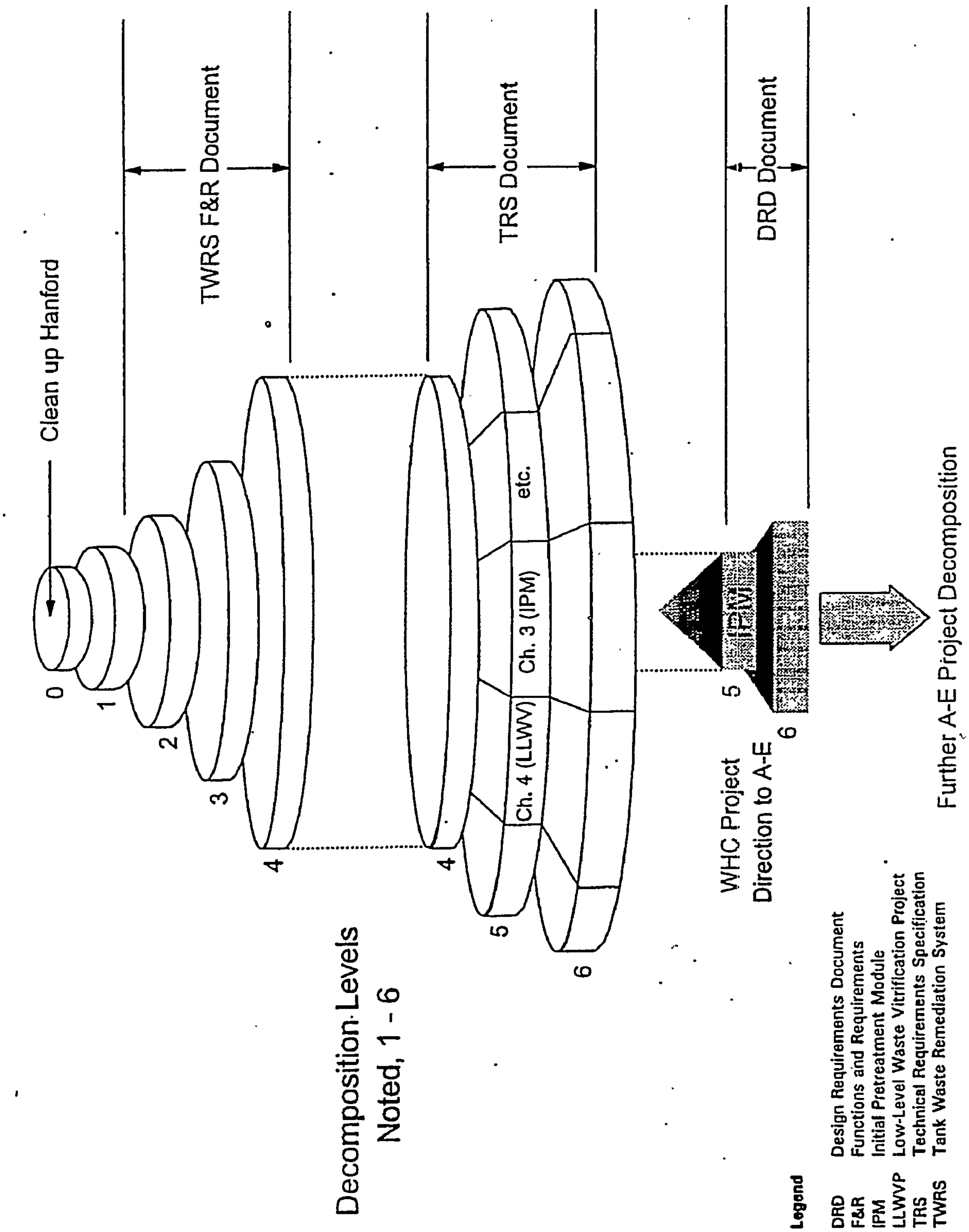
The purpose of this document is to establish the system level requirements for the fifth and sixth level function, "Pretreat Supernatants," which has been allocated to the IPM, Project W236-B. The document identifies the systems for this function, the system performance requirements, and how the system must interface with the TWRS program. The document also provides the baseline control of the project scope between DOE and the Pretreatment program and provides traceability to upper TWRS program requirements.

The IPM project scope includes facilities required to separate tank waste supernatants into low-level and high-level fractions. The major unit operations will include solid/liquid separation, cesium ion exchange, feed and product concentration. Tank waste supernatants are existing tank liquids, liquids generated from pretreatment of tank waste sludges/solids, and liquids from treatment of gaseous and liquid effluents associated with immobilization of tank wastes.

Uncertainties associated with the current TWRS planning basis that may impact the scope of the IPM and the effect of open issues on design requirements are discussed in Section 6.0. The uncertainties addressed in Section 6.0 are derived from the functional and requirements analyses of the Pretreat Supernatant function and from adopting the planning basis (DOE 1994b) for the Pretreatment program. Technical and programmatic risks associated with the planning basis are discussed in the *Tank Waste Remediation System Decisions and Risk Assessment* (Johnson 1994).

The design requirements provided in this document will be augmented by additional detailed design data contained in supplemental design documents.

Figure 1-2. Tank Waste Remediation System Functional Decomposition and Documentation.



This page intentionally left blank.

2.0 APPLICABLE DOCUMENTS

2.1 GOVERNMENT DOCUMENTS

Federal government and Washington State regulations along with DOE orders have been reviewed to determine constraints applicable to the design, construction, and operation of the IPM. Constraints that apply to the IPM are provided in Section 3.2. Those documents containing applicable constraints are identified in Table 2-1.

Table 2-1. Applicable Constraint Documents. (3 sheets)

Document Identifier	Title
a. Source Documents for the Physical Systems	
10 CFR 61	Licensing Requirements for Land Disposal of Radioactive Waste
40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)
Bernero 1993	Bernero, NRC letter dated March 2, 1993
DOE Order 5400.5	Radiation Protection of the Public and the Environment
DOE Order 5480.11	Radiation Protection for Occupational Workers
DOE Order 5820.2A	Radioactive Waste Management
DOE Order 6430.1A	General Design Criteria
DOE RL Order 6430.1C	Hanford Plant Standards
DOE RL Order 90-43, Rev. 0, 1 Part B	Liquid Effluent Retention Facility Dangerous Waste Permit Application
RLID 5820.2A	Radioactive Waste Management
RLIP 5480.11	Radiation Protection for Occupational Workers
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order (Amendment 4 approved January 1994)
WAC 173-200	Water Quality Standards for Groundwaters of the State of Washington
WAC 173-303	Dangerous Waste Regulations
WAC 173-480	Ambient Air Quality Standards and Emission Limits for Radionuclides
WAC 246-247	Radiation Protection - Air Emissions

Table 2-1. Applicable Constraint Documents. (3 sheets)

Document Identifier	Title
b. Source Documents for Programmatic Requirements	
40 CFR 260	Hazardous Waste Management System: General
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
42 USC 6901	Resource Conservation and Recovery Act of 1976 (RCRA) and Hazardous and Solid Waste Amendments of 1984 (HSWA)
DOE Order 5400.3	Hazardous and Radioactive Mixed Waste Program
DOE Order 5480.10	Contractor Industrial Hygiene Program
DOE Order 5480.19	Conduct of Operations Requirements for DOE Facilities
DOE Order 5480.21	Unreviewed Safety Questions
DOE Order 5480.22	Technical Safety Requirements
DOE Order 5480.31	Startup and Restart of Nuclear Facilities
DOE RL Order 5440.1A	Implementation of the National Environmental Policy Act at the Richland Operations Office
DOE RL Order 6430.1C	Hanford Plant Standards (HPS) Program
RCW 70.105	Washington Hazardous Waste Management Act
RLIP 5480.4C	Environmental Protection, Safety, and Health Protection Standards for RL
RLIP 5480.21	Unreviewed Safety Questions
RLIP 5480.22	Technical Safety Requirements
c. Source Documents with no TWRS Requirements (Reviewed by Systems Engineering and determined to be N/A).	
40 CFR 257	Criteria for Classification of Solid Waste Disposal Facilities and Practices
40 CFR 260	Hazardous Waste Management System: General
40 CFR 266	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 270	EPA Administered Permit Programs: The Hazardous Waste Permit Program
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 302	Designation, Reportable Quantities and Notification
DOE 5400.4	Comprehensive Environmental Response, Compensation, and Liability Act Requirements
DOE 5440.1E	National Environmental Policy Act Compliance Program

Table 2-1. Applicable Constraint Documents. (3 sheets)

Document Identifier	Title
DOE 5480.1A	Environment, Safety, and Health Program for Department of Energy Operations for Richland Operations
DOE 5480.1B	Environment, Safety, and Health Program for Department of Energy Operations
DOE 5480.5	Safety of Nuclear Facilities

2.2 NON-GOVERNMENT DOCUMENTS

2.2.1 Hanford Site Documents

Several of the DOE orders, federal government and Washington State regulations have been reviewed by Westinghouse Hanford Company to provide a consistent interpretation of the constraints for application at the Hanford Site. Constraints that have been interpreted are provided in Section 3.2. Reference documents are identified in Table 2-2.

Table 2-2. Westinghouse Hanford Company Documents Interpreting Constraints.

Document Identifier	Title
HSRCM-1	*Hanford Site Radiological Control Manual*
WHC-CM-2-6	*Data Standards*
WHC-CM-7-5	*Environmental Compliance*
WHC-SD-WM-ES-295	*Tank Waste Remediation System Facility Configuration Study*
WHC-EP-0786	*Tank Waste Remediation System Decisions and Risk Assessment*
WHC-SD-WM-TI-613	*Tank Waste Remediation System Process Flowsheet*

The U.S. Department of Energy - Richland Field Office has prepared a collection of Hanford Site specific requirements and specifications called Hanford Plant Standards. These Hanford Plant Standards are used in addition to nationally recognized codes and standards. Nationally recognized codes and standards are used wherever possible; Hanford Plant Standards are developed where a national standard is insufficient or has not been developed. Table 2-3 lists the Hanford Plant Standards.

Table 2-3. Hanford Plant Standards.

Standard number and title		Revision	Date
General			
SDC-1.2	Hanford Plant Standards and National Codes and Standards	R11	2/14/83
SDC-1.3	Preparation and Control of Engineering and Fabrication Drawings	R6	2/19/90
SDC-1.4	Preparations and Control of Multiuse Hanford Specifications	R0	6/19/81
Architectural-civil			
SDC-3.1	Standard Design Criteria for Railroads	R6	8/20/73
SDC-3.2	Minimum Depth of Underground Water Lines	R2	8/20/73
SDC-4.1	Design Loads for Facilities	R12	9/03/93
SDC-4.2	Design and Installation of Expansion Anchors	R0	10/08/92
Mechanical			
SDC-5.1	Heating Ventilation, and Air Conditioning	R7	2/28/79
Electrical			
SDC-7.2	Outside Lighting and Aerial Distribution Systems	R16	3/26/81
SDC-7.4	Underground Power Distribution	R15	1/22/82
SDC-7.5	Interior Power and Lighting	R25	4/15/86
SDC-7.7	Communications, Signaling, and Low-Voltage Control Systems	R8	5/15/73
SDC-7.8	Fire Alarm Systems	R14	12/21/93
Safeguards and security			
SDC-8.1	Installation Details for Safeguards/Security Equipment	R0	3/12/91

2.2.2 Process Flowsheet

A reference process flowsheet has been developed for treatment and disposal of Hanford Site tank wastes (Orme 1994). This process flowsheet provides information on the expected performance of the IPM and the interactions between this facility and other components of TWRS. Section 3.2.1 contains the expected system performance requirements derived from the reference process flowsheet.

The reference process flowsheet is intended to be used as a guide. The Architect/Engineer must derive detailed mass and energy balance flowsheets for the IPM consistent with the requirements specified in this document. If the Architect/Engineer determines the interface conditions or requirement specified in this document cannot be satisfied, the Architect/Engineer must notify the Integrating Contractor (WHC) of the condition and request modification to this document.

This page intentionally left blank.

3.0 SYSTEM REQUIREMENTS

3.1 DEFINITIONS

The functions, function flow diagrams, and key interfaces which define the pretreatment system are provided in the following sections. TWRS Program System Engineering is using Integrated Computer-Aided Manufacturing Definition, a software diagramming tool, to produce and maintain the functional flow diagrams.

3.1.1 Project Definition

The *Tank Waste Remediation System Functions and Requirements* (DOE 1994) established Function 4.2.2.3: Pretreat Waste. The overall function of pretreat waste is to provide initial solids/liquid separation from retrieved tank wastes and additionally pretreat the resultant liquids using a cesium removal process. The Pretreat Waste function is defined in the TWRS functions and requirements as: "Separate tank waste into a HLW/transuranic (TRU) fraction and LLW fractions suitable for immobilization and into a fraction suitable for reuse. Pretreatment includes preparing all retrieved tank waste for separations processes, separating the waste constituents suitable for immobilization and LLW and for reuse, and converting the remaining waste into feeds to the HLW and TRU waste immobilization system. Tank waste will be pretreated when needed to provide feed for LLW immobilization and/or provide feed for HLW and TRU immobilization." The feed to the Pretreat Waste function is received from the Retrieve/Transfer Waste function, 4.2.2.1.

The Pretreat Waste function has been decomposed into two functions: Pretreat Sludges/Solids (4.2.2.3.1) and Pretreat Supernatant (4.2.2.3.2). The IPM project consists of the functions necessary to accomplish the Pretreat Supernatant function and the Concentrate Waste function (4.2.1.4). The Pretreat Supernatant function has been further decomposed into subordinate functions essential for the performance of the system:

4.2.2.3.2.1 Separate Radionuclides. All functions required to separate the supernatant solution into pretreated LLW and radionuclides (primarily cesium and entrained solids).

4.2.2.3.2.2 Analyze PS Samples. All functions required to collect and analyze process control and regulatory samples. Analyses include laboratory and on-line analyses. Sample collection and transport are included as subfunctions to this function.

4.2.2.3.2.3 Monitor and Control PS Process. All functions required to analyze incoming process information (e.g., analytical results, instrumentation signals, etc.) and effect appropriate process control actions. This includes the collection and analyses of sample information and instrument data for feedback control of the pretreatment process, offgas treatment, liquid effluent treatment equipment, and process building support systems. This function provides the means to track the history and performance of the pretreatment process to ensure the process inputs, process generated intermediate streams, and final products meet process and/or product specifications.

4.2.2.3.2.4 Support Pretreatment Process. All functions required to supply utilities (e.g., electrical power), distribute raw materials and reusable materials, and physical structure for the pretreatment of supernatants of LLW. Distribution of utilities are included under this function. Treatment and disposition of secondary wastes; gaseous effluent, liquid wastes, and solid wastes, generated as a result of pretreatment activities are included as subfunctions to this function.

Table 3-1 shows the function flow diagram using the N-Square diagram for the functions. Numbers in each function block correspond to appropriate function numbers as identified above. The function flow diagrams identify the primary interactions between the functions in accepting supernatants for pretreatment.

Table 3-1. N-Square Chart for 4.2.2.3 Pretreat Waste.

• Supernatants		• Tank Characterization Information	• Raw Materials for PS	
(4.2.2.3.2.1) Separate Radionuclides	• PS Process Control Samples	• PS Process Instrumentation and Control Data	• PS Process Condensates • PS Process Generated Solid Waste • PS Process Vessel Offgas	• Pretreated low-level waste • Recycled Water for Retrieval • Separated Radionuclides
• PS Process Sample Residue	**(4.2.2.3.2.2) Analyze PS Samples**	• PS Sample Results	• PS Analytical Lab Liquid Waste • PS Analytical Lab Solid Waste	
• PS Process Control Action		**(4.2.2.3.2.3) Monitor and Control Pretreat Supernatant Process**	• Support Pretreatment Process Control Action	• PS Characterization Requirements • Supernatant Characterization Requirements
• PS Bulk Chemicals • PS Utilities	• PS Bulk Chemical Samples • PS Bulk Chemicals • PS Utilities	• PS Utilities • Support Pretreatment Process Instrumentation and Control Data	**(4.2.2.3.2.4) Support Pretreatment Process**	• PS Excess Facilities • PS Prepared Solid Waste • PS Treated Gaseous Effluents • PS Treated Liquid Effluents • Recycled Condensate to Pretreat Sludges/Solids

PS = Pretreat Supernatant.

The IPM project shall provide equipment and facilities for accomplishing these functions and includes the design and construction of the receipt, treatment, and transfer of the low activity supernatant stream for further processing, or storage, accomplished by Function 4.2.2.4, Immobilize and Dispose of LLW. Processing, storage and/or transfer of separated HLW for HLW vitrification processing is accomplished by Function 4.2.2.5, Immobilize, Store, and Ship HLW.

3.1.2 System Definition

Supernatants generated from sludge washing operations and decanted tank supernatants from the existing tanks wastes are received by the IPM, Project W236-B. The pretreated supernatants are feed to the LLW Vitrification Process and must meet the LLWVP feed requirements.

The IPM project scope includes facilities required to pretreat the retrieved tank wastes. Tank wastes are retrieved, transferred, and pretreated before LLW vitrification. Pretreatment of the liquid supernatants consists primarily of concentration (function 4.2.1.4), filtration, and cesium separation (function 4.2.2.3.2). The cesium depleted eluent from pretreatment provides feed to the LLW vitrification process and the concentrated cesium will be processed in the HLW vitrification process.

The major unit operations for the IPM will include solid/liquid separation, cesium ion exchange, feed and product concentration, support systems (e.g., chemical storage, utilities, offgas treatment, liquid effluent treatment, disposition of solid waste), and systems for transferring the concentrated cesium to HLW storage and the cesium depleted eluent to the LLW vitrification process.

3.1.3 Interface Definition

The interfaces to the IPM consist of programmatic and administrative interfaces, physical interfaces, and functional interfaces as shown in Figure 3-1. As a new facility, the IPM must interface with the existing TWRS infrastructure and other proposed facilities and projects. The physical interfaces for the IPM are discussed below.

The existing TWRS configuration consists of 28 DSTs, 149 single-shell tanks (SSTs), an evaporator, transfer pipelines, and miscellaneous waste storage support facilities (e.g., 204-AR railcar waste receipt/unloading facility). The TWRS receives liquid HLW from other programs and transfers aqueous effluents to the Liquid Effluent Treatment Facility (LETF) and the Solid Waste Disposal Program. Several new TWRS projects will be required for waste pretreatment, vitrification and final disposal. Continued operations will require a series of upgrade projects to improve the compliance of the TWRS with environmental regulations. Some facility replacement will be needed since parts of the system have either failed or exceeded their useful life.

Figure 3-2 shows the current TWRS configuration along with the other necessary activities for waste disposal. This figure depicts the current complex with icons and the future additions as text in boxes. As each system becomes more defined, interface requirements will become more detailed.

Figure 3-1. Pretreat Supernatant Interfaces and Boundaries.

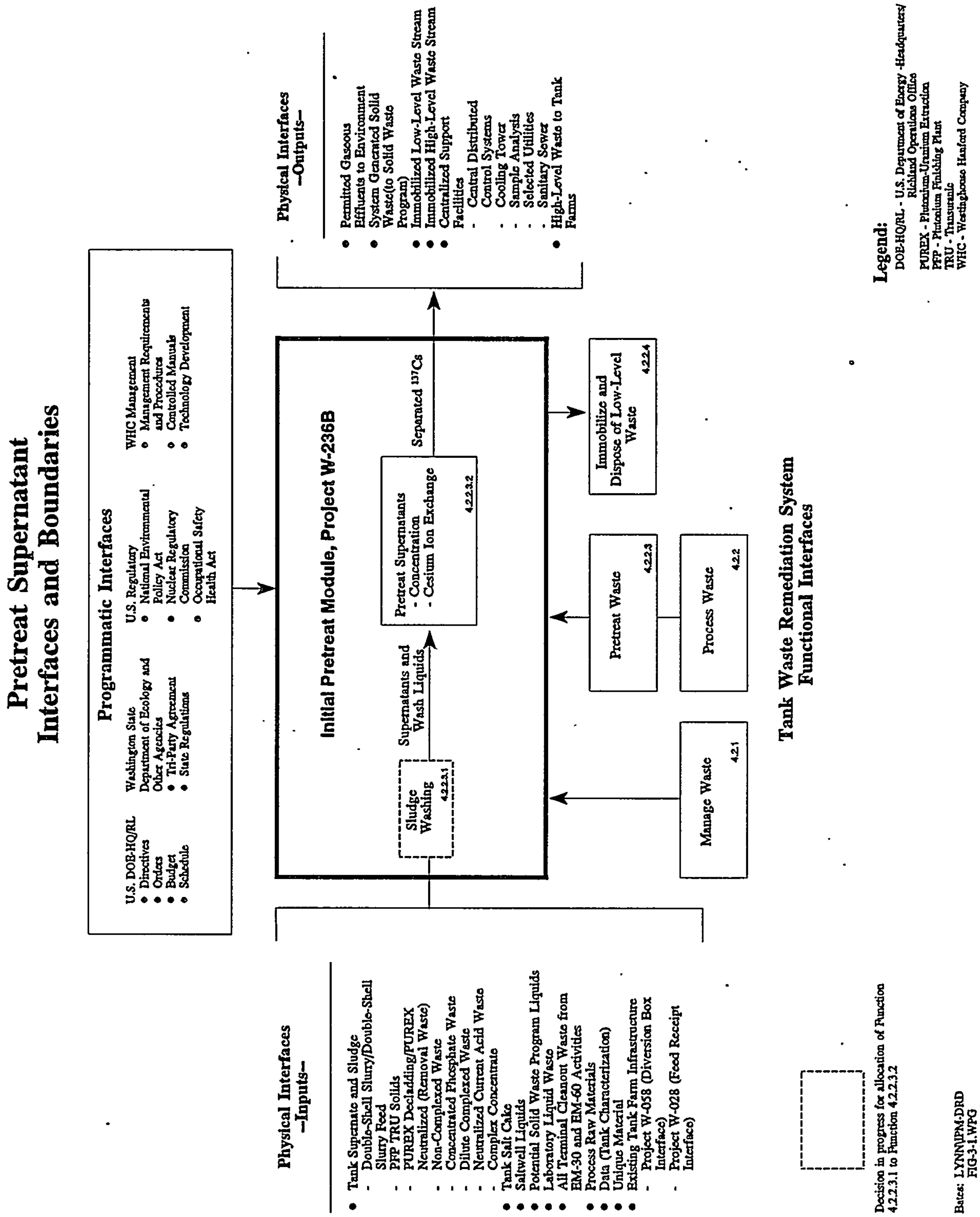
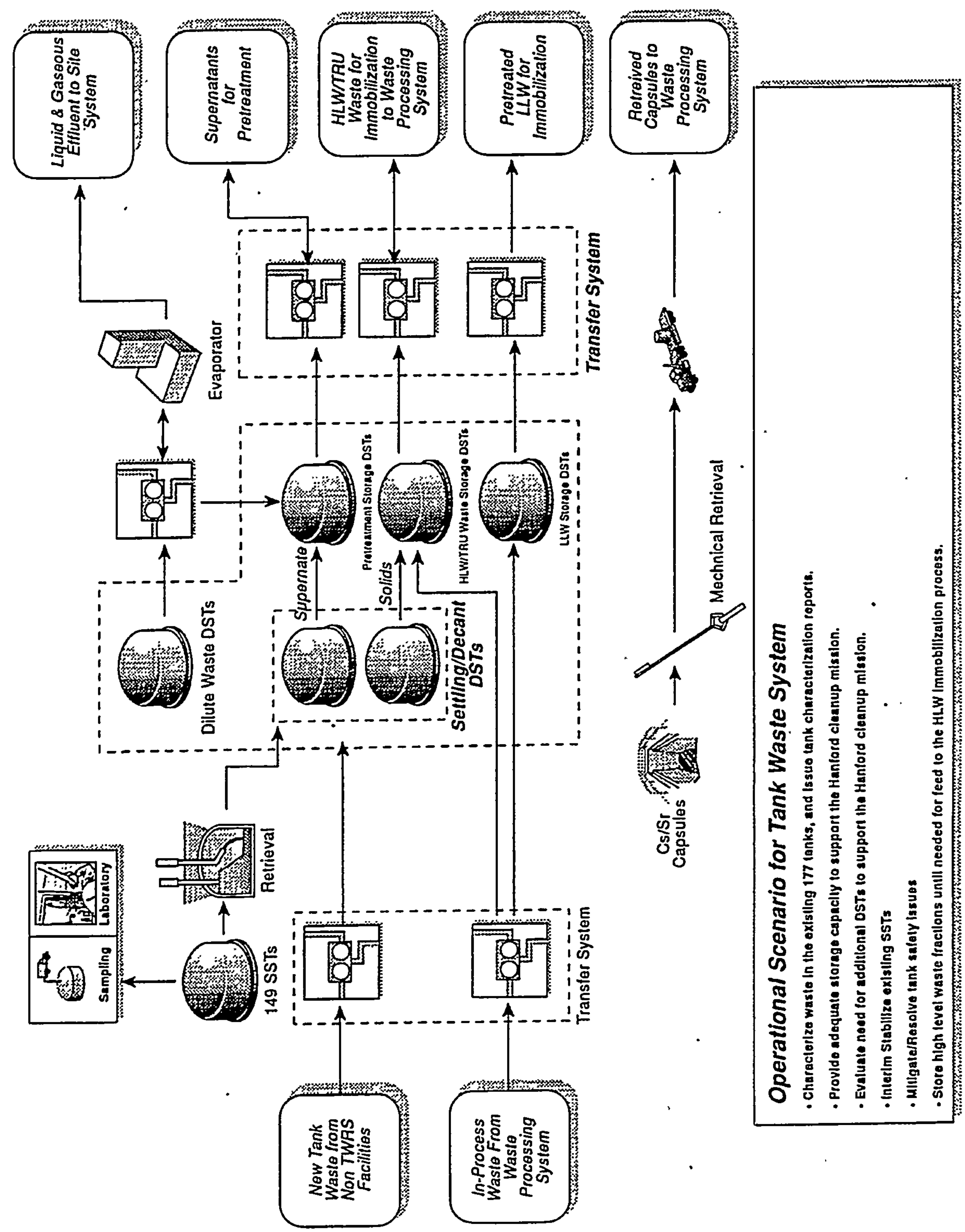


Figure 3-2. Tank Waste Remediation System.



The primary physical interfaces for the IPM are those necessary for (1) receipt of the supernatant stream, (2) transfer of the pretreated supernatants to the Immobilize and Dispose of LLW function and, (3) transfer of secondary waste products (e.g, treated liquid effluents, treated gaseous effluents, and treated solid wastes) to interfacing Hanford site programs or to a centralized support facility(s). The TWRS current planning basis assumes a pretreatment facility (provided by Project W236-B) operating in conjunction with the LLW vitrification plant (LLWVP). Therefore, lag storage of pretreated LLW in existing DSTs is not planned. However, should lag storage be required as a contingency, underground transfer pipelines routing from existing DSTs to the LLWVP or new tanks designated for lag storage will be provided by the Immobilize and Dispose of LLW function.

Programmatic interface control documents are being prepared for each of the IPM interfaces with other Hanford Site programs.

3.2 CHARACTERISTICS

Characteristics are the specific constraints and expected system performance requirements identified for the IPM project. Characteristics are categorized as follows, with specific requirements provided for the IPM project in the subsequent sections:

Section 3.2.1, Performance Characteristics: Describes the generalized capabilities and expected system performance requirements a system would have to achieve the portion of the TWRS mission allocated to it.

Section 3.2.2, System Capability Relationships: Describes when the system must be operational in relationship to other systems operating to achieve the TWRS mission. (This is a modification of the definition used in Mil-Std 490, type A specification)

Section 3.2.3, External Interface Requirements: Describes requirements for interfaces with other systems.

Section 3.2.4, Physical Characteristics: Describes physical limits for the system such as transportation and storage, durability, safety, security, vulnerability, and protective coatings.

Section 3.2.5, System Quality Factors: Describes reliability, maintainability, availability, and other additional quality factor requirements for the system.

Section 3.2.6, Environmental Conditions: Describes the environmental conditions which the system must withstand during transportation, storage, and operations.

Section 3.2.8, Flexibility and Expansion: Describes areas of growth or modification which require planning for system flexibility and expansion. Specific system elements requiring spare capacity to support flexibility and expansion are described.

Where specific requirements have not been identified for a characteristic, it is noted in the appropriate section that no requirements have been identified. If additional information must be developed to verify or derive a requirement, the preliminary requirements is listed, an issue identified and a description is provided of the required analysis to resolve the issue. The function that corresponds to the identified characteristic (i.e., requirements) has been noted in parenthesis following each requirement.

3.2.1 Performance Characteristics

This section provides the process design criteria for the IPM project. These criteria are based on a processing strategy identified in the TWRS Reference flowsheet document. A process block flow diagram representing the major elements for pretreatment processing is shown in Figure 3-3.

3.2.1.1 Throughput. The nominal design throughput of supernatant feed shall be 215 L/min (time averaged, steady state). Maximum and minimum throughputs will be defined by the operational feed variabilities. (Function 4.2.2.3.2)

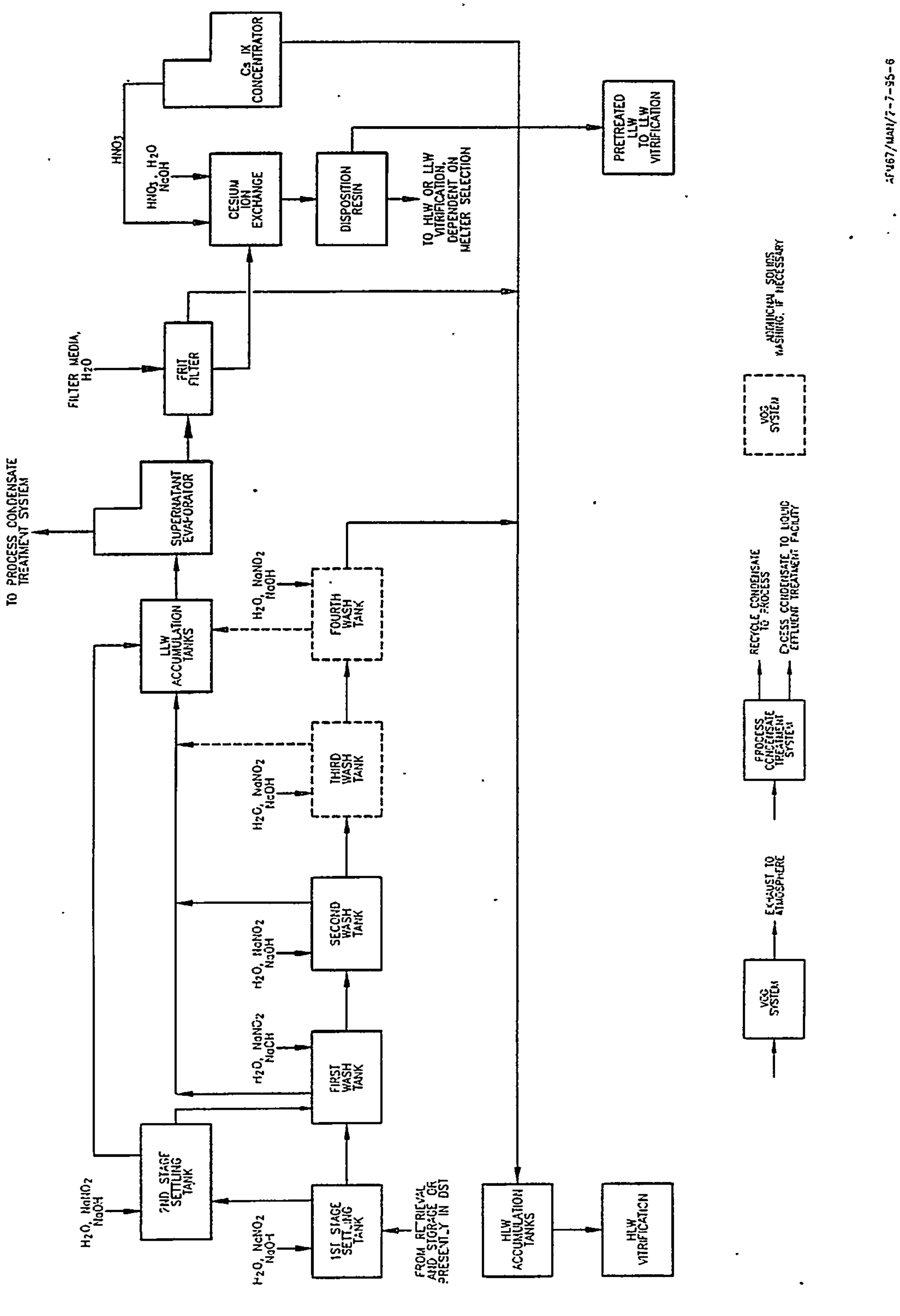
Basis: Orme 1994. The throughput volume is based on a total volume of 9.49E8 L of a 3 to 4 *M* sodium solution. For a 14-year operating life, at a 60 percent total operating efficiency, the instantaneous throughput is 215 L/min. This volume does not account for internal recycle from filter washes, condensates, etc., which also must be considered during conceptual design.

Additional feed to the PS may include waste from 51 miscellaneous underground storage tanks. Although the waste in the miscellaneous underground storage tanks are not currently within the TWRS scope, this may change in the future, but due to the inventory characteristics known to date, this is not considered to result in design change (Alumkal 1994b). An assessment of impact to the project is documented in the Tank Utilization Trade Study, E/B-SD-W236B-RPT-016.

3.2.1.2 Process Feed Variability. The initial process design shall be based on the feed compositions defined by WHC. Feed definitions required are: (1) nominal design feed, (2) shielding design feed, (3) safety/regulatory assessment feed, (4) criticality assessment feed, and (5) operational variability feed. (Function 4.2.2.3.2).

- Table A-1, Appendix A, defines the nominal design feed as represented in the TWRS reference flowsheet.
- Tables A-2 and A-3, Appendix A, define the range in chemical composition to be expected in double-shell slurry feed (DSSF).
- Table A-4, Appendix A, provides the estimated composition of LLW glass based upon candidate initial feed sources from supernatant pretreatment.

Figure 3-3. Pretreat Supernatant Process Block Flow Diagram.



Chemical and radionuclide concentrations for the other feed types (neutralized current acid waste [NCAW], complexant concentrate [CC], Plutonium Finishing Plant [PFP], and neutralized cladding removal waste) are pending completion of pretreatment processing flowsheets.

Basis: A variety of feed definitions are required to support design. These feeds include: (1) a nominal feed to provide total throughput based on a total volume of retrieved wastes; (2) a shielding basis feed composition represents a feed with elevated radionuclides which dominate shielding requirements as compared to the average plant conditions. This feed is used to define shielding requirements provided by the plant structure and equipment and represents material which would be in the facility for short campaigns and would not be used for evaluations of performance over the entire plant life; (3) a safety/regulatory assessment feed composition is a feed with bounding radionuclides which, if released, dominated the estimate of dose to personnel (both onsite and offsite) as compared to the average plant conditions. This feed is used to analyze design basis accidents and supports definition of mitigation systems; (4) a criticality assessment feed which is feed with elevated fissile material content used to define criticality controls which may impact the system design and; (5) a variability assessment feed which evaluates a range of feeds due to retrieval and blending scenarios as well as campaign runs of a particular type of feed.

Issue 1: Feed composition tables for the other required feed definitions are under development and must be completed by WHC before completion of conceptual design (Function 4.2.2.3.2).

Required Analysis: Feed composition tables for these feeds will be provided during conceptual design. A list of proposed feeds and the intended purpose of the feed definition are described in Appendix H of the *TWRS Facility Configuration Study* (Boomer et al. 1994). The facility flowsheet must be calculated using each feed type to provide a basis for material compositions and quantities which can be used in follow-on calculations.

3.2.1.3 Feed Receipt and Preparation. The IPM project shall provide sufficient lag storage of retrieved supernatants. Capacity TBD.

Issue: Based on the results of the trade study, *Sludge Washing* (E/B-SD-W236B-RPT-021), the lag storage volume for retrieved supernatants will be determined.

Required Analysis: Confirmation of the results of the trade study, *Sludge Washing*, (E/B-SD-W236B-RPT-021), must be completed.

3.2.1.3.1 Sludge Washing. Sludges shall be washed with aqueous solutions to dissolve certain non-radioactive solids to minimize waste loadings to HLW vitrification. The number of washes, composition, quantity, temperature, and contact times of the liquid/solids contacts will be optimized during conceptual design by the project and shall be consistent with the WHC baseline flowsheet.

Issue 1. Confirmation of the results of the Sludge Washing Trade Study (E/B-SD-W236B-RPT-021) is required to allocate Function 4.2.2.3.1, Pretreat Sludges/Solids, to the IPM project scope. Process variables for the sludge washing operations must be developed.

Required Analysis: The WHC/DOE decision panel must confirm the recommendation to provide "In-facility" sludge washing and document allocation of function 4.2.2.3.1, Pretreat Sludges/Solids to the IPM project. The sludge washing flowsheet is scheduled for completion March 1995.

3.2.1.3.2 Feed Adjustment. The supernatants from Pretreat Sludges/Solids (Function 4.2.2.3.1) shall be adjusted to provide a nominal 5 *M* sodium solution and a maximum 7 *M* sodium solution to the ion-exchange column (Function 4.2.2.3.2.1).

1. Concentration of the blended average of the supernatants and wash solutions (approximately 4 to 5 *M* sodium) to a maximum of 7 *M* results in a volume of 473 E+06 L feed for cesium removal (Orme 1994). Adjustment of the feed to the cesium ion-exchange systems will vary according to waste type. Wastes above 7 *M* sodium solution shall be diluted to within the required range. Wastes below 5 *M* sodium solution shall be concentrated to within the required range. The IPM project will provide a system capable of these adjustments to concentration.

Basis: Experiments with simulated wastes (DSSF solutions, CC waste, and NCAW) performed by PNL provide equilibrium data for cesium ion-exchange suggests a maximum 7 *M* sodium solution to the column. Reference data *Analysis of Equilibrium Data For Cesium Ion Exchange of Hanford CC and NCAW Supernatant Liquid--Status Report*, TWRSPP-93-051 (Kurath et al. 1993).

Issue 1: The maximum sodium concentration in the feed to the column has not yet been determined with actual wastes. Existing DSSF tank supernatant is currently at 10 to 11 *M* sodium solution. An 8 *M* solution has been found to float the resin. Therefore, dilution will be necessary.

Required Analysis: Continue experimental tests with actual waste to verify maximum sodium concentration of ion-exchange feed. Initial laboratory data are in *Cesium Ion Exchange Using Actual Waste: Column Size Considerations*, TWRSPP-94-091, (Brooks 1994). Continue laboratory testing as defined in *Testing and Development Strategy for the Tank Waste Remediation System*, WHC-SD-WM-SP-006 (Reddick 1994).

2. Feed adjustments (i.e., mixing) may also be needed to provide a pretreated feed of. < 3 percent P_2O_5 and 0.5 percent Cr_2O_3 to LLW vitrification.

Basis: Retrieval sequencing will be the primary tool to keep P_2O_5 and Cr_2O_3 below the specified limits. Aluminum does not require blending, but is a component that may be added to the LLW feed preparation. No other constituents must be blended.

Issue 2: Establish the validity of a limited or "no blending" requirement for the IPM.

Required Analysis: Current analyses of LLW glass variability/blending as a function of retrieval must be completed and documented.

3. The Concentrate Waste function (4.2.1.4) is defined as the removal of excess water from liquid double-shell tank (DST) waste to reduce the volume of waste feed for treatment and to free up storage capacity in existing tanks. This function is currently being performed by the 242-A evaporator. The scope of the IPM project must address replacement of the 242-A Evaporator in approximately 10 years (e.g., life expectancy of 242-A Evaporator).

Basis: Evaporation trade study, E/B-SD-W236B-RPT-022.

3.2.1.3.3 Soluble TRU Removal. Project W-236B shall include the flexibility to add soluble TRU removal as a facility option by including contingency space or providing routings to a future annex (see item 3.2.1.3.4, Solids/Liquid Separation, for requirements on insoluble TRU removal).

Issue 1: Liquid wastes that contain too much soluble TRU to satisfy LLW specifications will have a pH adjustment and/or receive a complexant destruction treatment to reduce the complexing strength of the solution. This treatment may be done in the DSTs.

Required Analysis: An assessment of the impacts of pretreatment options for sludges/solids must be evaluated. Separation technologies applied to sludge washing will be assessed for impacts to pretreat supernatant requirements. (Trade Studies: *In-Tank Radionuclide Separation*, E/B-SD-W236B-RPT-018; *Solid/Liquid Separation*, E/B-SD-W236B-RPT-019; *Sludge Washing*, E/B-SD-W236B-RPT-021; PNL report: *Fiscal Year 1995 Technology Development Plan*, Draft; *Summary Letter, Laboratory Testing In-Tank Sludge Washing*, TWRSPP-93-060 [Norton and Torres-Ayala 1993].)

3.2.1.3.4 Solids/Liquid Separation. Primary solids/liquid separation is provided by settle/decant operations in the existing DSTs. Secondary filtration of entrained solids from decanted supernatants prior to concentration shall be provided by the IPM project. Solids removal from the retrieved supernatants shall meet the most restrictive of the following two specifications:

1. Remove entrained TRU solids so that the sum of soluble TRU and insoluble TRU results in a concentration of less than <540 nCi TRU/g Na (less than 65 nCi TRU/g glass) (Function 4.2.2.3.2.1).

2. Entrained solids shall be removed from the retrieved supernatants to a maximum of 100 ppm.

Basis: Baseline flowsheet, Orme 1994 and calculation sheet found in Appendix B. Feed to the radionuclide separation process (e.g., cesium removal) is filtered for final solid/liquid clarification. The suspended solids within retrieved tank wastes and sludge wash solutions (e.g., NCAW liquid fraction) are known to contain transuranic (TRU) elements and strontium particulates. Filtration for solids carry over is required to meet the LLW radioactivity limits.

Issue 2: The behavior of TRU during feed preparation and concentration operations needs continued analysis to form a basis for TRU solids removal in the IPM facility.

Required Analysis: Provide documentation and expected range of entrained solids carried over from the pretreat sludges/solids function. Continue evaluation of the solubility behavior of TRU. The results of the Sludge Washing (E/B-SD-W236B-RPT-021), Radionuclide Separation Study (E/B-SD-W236B-RPT-019), and Solid/Liquid Separation (E/B-SD-W236B-RPT-020) Trade Studies must be finalized and the decision documented. Sludge washing laboratory data have been collected and documented in TWRSTP-93-060 (Norton and Torres-Ayela 1993).

3.2.1.3.5 Caustic Recycle. The system design shall incorporate internal/direct recycle of dilute caustic streams.

Basis: Trade Study *Caustic Recycle*, E/B-SD-W236B-RPT-024, has determined the feasibility of condensate recycle.

3.2.1.4 Radionuclide Separation.

3.2.1.4.1 Cesium Separation.

1. Cesium-137 shall be removed to achieve less than 7.0 MCi (decay date December 31, 1999) total radionuclides for disposal in the LLW glass. The 7.0 MCi includes the total insoluble and soluble Cs-Ba and Sr-Y for the DST and SST tank inventory.

Basis: See Appendix B for complete basis statement. An average decontamination factor of 100 is necessary to remove a quantity of ^{137}Cs which will satisfy the intent of the Nuclear Regulatory Commission (NRC) "incidental waste" classification (Bernero 1993). A cesium decontamination factor (DF) of 100 results in an average cesium concentration of 1 Ci/m^3 in the LLW glass. The average cesium decontamination factor (influent cesium to sodium ratio concentration divided by effluent cesium to sodium concentration) for pretreatment of tank wastes is approximately 100. The trade study evaluating facility design parameters (i.e., shielding requirements) necessary and the facility cost of additional cesium removal (Cesium DF = 10,000 and Strontium DF=100) is documented in Boomer et al. (1994).

2. Cesium shall be removed by ion exchange and loaded on the exchange media at high alkaline conditions (pH >=12) at about 25 °C.

Basis: The current TWRS planning is for cesium removal via ion exchange under current waste conditions (alkaline) as opposed to acid side processing. The selection of cesium ion exchange is based on the information provided in *Initial Evaluation of Two Organic Resins and Their Ion Exchange Column Performance for the Recovery of Cesium from Hanford Alkaline Wastes*, TWRSPP-93-055 (Bray et al. 1993) and the *Tank Waste Technical Options Report*, WHC-EP-0616, Appendix G (pages G1-3 - G1-23) (Boomer et al. 1993). Separation processes that have been evaluated are summarized below.

A number of studies have evaluated cesium separation processes for application to Hanford Site tank wastes. Organic cation exchange resins were employed very successfully at the Hanford Site on a plant-scale for many years to remove ^{137}Cs from alkaline wastes. Such technology, using newer resins (e.g., Duolite CS-100[1] and a resorcinol-based ion exchanger) are being evaluated (Bray et al. 1993).

Alternative methods for removing ^{137}Cs from alkaline solutions all appear to have disadvantages compared to well-established ion exchange technology. Silicotitanates and/or zeolites can be used for cesium ion-exchange, but contain significant amounts of aluminum, silicon, and sodium, which are limiting components in glass feed formulations. Various precipitation agents: e.g., tetraphenyl boron, nickel ferrocyanide, and phosphotungstate, must all be applied on a batch basis. Downstream processing of cesium-laden precipitates involves potential safety hazards. Candidate solvent extraction processes employing such extraction as BAMBP[2], dipicrylamine, polybromides, and crown ethers have not either been fully developed or require use of toxic diluents such as nitrobenzene.

---

[1]Duolite CS-100 is a registered trademark of Rohm and Haas, Philadelphia, Pennsylvania.

[2]-4-sec-butyl-2-(a-methylbenzyl)phenol

3.2.1.4.2 Strontium Separation. Project W236-B shall include the flexibility to provide ^{90}Sr removal as a facility option by including contingency space or providing routings to a future annex.

Basis: See Appendix B for discussion of "incidental waste" classification. For classification as incidental waste, the tank waste supernatants must be treated to reduce the total radionuclide content to 4 percent of the total curies. The current TWRS goal is to reduce the total radionuclide content of the LLW fraction to, or below, 7.0 MCi (1991 decay date). The percentage of the total estimated strontium inventory disposed in the LLW glass meets the NRC "incidental waste" classification. Also, an evaluation for a lightly shielded LLW vitrification facility is provided in Boomer et al. (1994), Appendix H. Strontium removal based on ALARA and facility life-cycle costs was determined to be undesirable.

Issue 1: A key action in the present Tank Waste Remediation System Technical Strategy for disposal of double-shell tank (DST) wastes is to determine the need and technical feasibility of in-tank destruction of organic complexants and concomitant or sequential removal of ^{90}Sr, transuranic elements, and, possibly, ^{99}Tc.

The initial results of the economic feasibility of ^{90}Sr removal has been documented (Boomer et al. 1994), but must be approved by DOE. Confirmation of the results of this study is required before ^{90}Sr removal capability can be removed from the project scope.

Required Analysis: The technical feasibility of the degree of ^{90}Sr removal (and other radionuclides), specification of a separations process, and the benefits of selected degree of separations is currently being developed. The report on *In-Tank Processes for Destruction of Organic Complexants and Removal of Selected Radionuclides*, WHC-SD-WM-ES-321, establishes the need for in-tank pretreatment processes and critically reviews existing in-tank pretreatment technology and processes. Approval of the conclusions in this document addresses Issue 1.

3.2.1.4.3 Technetium Separation. Project W236-B shall include the flexibility to add technetium removal as a facility option by including contingency space or providing routings to a future annex. The Performance Assessment documentation shall form the basis for a final decision on technetium removal requirements.

Basis: The NRC Class C Commercial LLW limit (as found in 10 CFR 61.55) for Tc is 3 Ci/m^3; the Class A limit for ^{99}Tc is 0.3 Ci/m^3. For current inventory values, the LLW glass product meets the Class A limit for ^{99}Tc with no ^{99}Tc removal from the supernatant stream.

Issue 1: It is not known (e.g., documentation of waste form disposal performance assessment criteria) if ^{99}Tc removal is required from the supernatants. The criteria for ^{99}Tc removal must also include the performance assessment criteria.

Issue 2: The current performance assessment strategy assumes (conservatively) that all the ^{99}Tc produced onsite is in the feed to the LLW vitrification facility.

Required Analyses: Determine the current ^{99}Tc inventory. The performance assessment of the LLW glass form will provide the basis for a decision on whether ^{99}Tc removal is required. Completed performance assessment data will verify the feed requirements (i.e. inventory of ^{99}Tc which becomes feed to pretreatment), glass formulation, and disposal system (i.e., barriers, matrix, etc.) for the LLW glass. (Trade Study for Out-of-Tank Radionuclide Separation, E/B-SD-W236B-RPT-023, addresses disposal system only.) Data on technetium volatility must be incorporated during conceptual design. The Tc inventory to be used for performance assessment calculations and flowsheet calculations must be consistent.

Evaluate the quantity of ^{99}Tc in previously cribbed evaporator condensates, ^{99}Tc in Uranium product from PUREX/REDOX, and the ^{99}Tc loss in decontaminated supernates which was sent to the cribs. Also, determine the quantity of ^{99}Tc which will be routed to HLW.

3.2.1.5 Pretreated LLW (Product).

3.2.1.5.1 The pretreated supernatant waste stream shall have radionuclides removed to meet the 10 CFR 61.55 Class C commercial waste criteria (using the sum of the fractions rule), and NRC's "incidental waste" classification (Bernero 1993) for the vitrified glass product. Incidental waste will be defined as 4 percent of the existing total radionuclide inventory.

3.2.1.5.2 The IPM shall include the flexibility to add complexant destruction as a facility option by including contingency space or providing routing to a future annex.

Issue 1 (Function 4.2.2.3.2): To ensure the vitrified LLW product is below the NRC Class C limit for TRU elements (TRU concentration less than 100 nCi/g), the waste solutions processed by the pretreat supernatant function must contain less than 65 nCi TRU/g (<540 nCi TRU/g Na) (Orme 1994). This may require an organic destruction process for removal of complexed TRU and strontium from the supernatant. Inclusion of organic destruction facilitates subsequent WHC isolation and study of complexant destruction techniques. Laboratory data are currently being generated and must be reviewed for applicability to the project. Heat and digest alone, or in conjunction with a pH adjustment, is a strategy that may be applied for removal of normally insoluble radionuclides from complexed solutions.

Required Analysis: Studies and experimental programs evaluating enhanced sludge washing, and possible organic destruction processes on the soluble TRU fraction, must be performed. (Trade Studies E/B-SD-W236B-RPT-019, E/B-SD-W236B-RPT-020, Solid/Liquid Separation, E/B-SD-W236B-RPT-021, Sludge Washing). Laboratory testing is currently being performed (tank 241-AN-107 waste). Laboratory testing on tank 241-SY-101 waste was completed by the WHC Process Chemistry Laboratories ("Organic Destruction Technology Development: Laboratory Testing--Heat and Digest, Tests 1, 2, and 3," Internal Memo #12110-PCL94-006). Results of the testing, to date, indicate the heat and digest process will not reduce the soluble TRU and strontium to acceptable concentrations.

3.2.1.5.3 The cesium depleted eluents (feed to LLWVP) shall be transferred to LLW Immobilization as a nominal 3.75 *M* Na solution (Function 4.2.2.3.2.1).

Basis: *TWRS Process Flowsheet*, WHC-SD-WM-TI-613 (Orme 1994). Concentration of the pretreated LLW will be provided by the Immobilize and Dispose LLW, Function 4.2.2.4.

3.2.1.5.4 Separated HLW (to function 4.2.2.5) includes separated entrained solids from supernatants, and spent ion exchange media (containing primarily cesium and possibly other radionuclides), and shall be transferred for storage and treatment to the Immobilize, Store, and Ship HLW function (4.2.2.5)

Issue 1: The activity and waste classification (e.g., HLW, LLW, hazardous, mixed waste) of the spent ion exchange media is not known. The current strategy (Orme 1994) specifies that the spent ion exchange media will be disposed to LLW. The disposition of the ion exchange media is dependent on the melter selections of both the HLW and LLW melter systems.

Required Analyses: The development and selection of the ion exchange resin and configuration of ion exchange columns is ongoing. (PNL report TWRSPP-94-091, *Cesium Ion Exchange Using Actual Waste: Column Size Considerations*, Brooks 1994). Trade study *Ion Exchange*, E/B-SD-W236B-RPT-025, Rev. 0, reviewed the ion exchange material selection, classification and disposition of the spent ion exchange media, and associated costs. The study findings recommend dewatering of the spent ion exchange material prior to disposal. Elutable resins will be disposed to LLW vitrification and nonelutable resins to HLW vitrification.

3.2.1.6 Process Monitor and Control.

3.2.1.6.1 Continuous Monitoring Sensitivity. Monitoring systems shall alarm at emission concentrations as low as possible without resulting in an excessive number of alarms due to normal fluctuations in background or normal fluctuations in emissions. The alarms are intended to provide timely warnings when the radionuclide concentration or content of emissions has increased significantly so that corrective actions are required to prevent their exceeding the discharge limits. The alarm settings for a specific facility may be selected by the cognizant engineer of the facility who has detailed knowledge of both its process design and its operating experience. Documentation of the various alarm settings and the bases for their selection shall be provided in the applicable Facility Effluent Monitoring Plan (FEMP).

Basis: DOE/EP-0096, Section 2.2, page 2.6, states that strategy for setting action levels must take into account the possibility for gross upset and the possibility for subtle changes in effluent concentration that may precede more severe upset conditions. DOE/EH-0173T, Chapter 3.0, Section 3.3.

Monitoring systems shall, as a minimum, have the capability to alarm at less than or equal to the time-integrated equivalent concentration equal to a 4-hour release at 5,000 times the DCG-public value, as noted in Appendix C of DOE/EP-0096, Section 2.2, page 2.6.

Basis: DOE/EH-0173T, Chapter 3.0, Section 3.6, states that continuous monitoring systems shall have alarms set to provide timely warnings when concentrations of radionuclides increase significantly.

Systems for monitoring specific radionuclides (including tritium, C-14, radioiodine, or noble gases) shall follow the guidance of DOE/EH-0173T, Chapter 3.0, Section 3.5.8.

Basis: WHC best management practice. This requirement recognizes the limitations of practical monitoring equipment currently available for some specific radionuclides, while requiring application of reasonable technology as it becomes available.

Basis: 40 CFR 61, Subpart H, Section 61.93(b).

3.2.1.6.2 Liquid Level Controls. Engineering controls shall be incorporated to provide liquid volume inventory data and to prevent spills, leaks, and overflows from tanks or other containment systems. Other requirements are located in DOE Order 5820.2A, Chapter I 3.b(2)(h) (Function 4.2.2.4 C63).

3.2.1.6.3 Monitor Feed Receipt and Lag Storage. Vessels used to receive and provide lag storage of supernatant solutions anywhere in the pretreat supernatant function need liquid level, solution density, solution temperature, and absolute pressure in the vessel vapor space monitoring capability. Control capabilities (e.g., alarms, interlocking devices to shut down or regulate the operation of equipment) are needed for the following:

- Vessel liquid level to avoid over-filling vessels
- Absolute pressure to alert personnel to conditions where the pressure within a vessel exceeds the surrounding environment pressure

- Solution temperature to regulate the cooling of process solutions and alert personnel to off-normal temperature conditions.

3.2.1.6.4 Monitor Process Vessel Offgas.

1. The inlet vessel offgas stream to the treatment equipment shall have monitoring and control capabilities to determine humidity, temperature, pressure, and flowrate.

2. The offgas stream discharged from the vessel offgas treatment equipment shall have monitoring and control capabilities to determine humidity, temperature, pressure, and flowrate.

3. For any condensers, heaters, absorbers, or scrubbers used in the vessel offgas treatment system, monitoring and control capabilities shall be provided for inlet and outlet vapor phase temperature, vapor phase pressure drop across unit, outlet vapor phase humidity, and radionuclide detection in the heat exchanger (i.e. condensers or heaters) exchange fluid.

4. For liquid accumulation and storage vessels associated with the offgas treatment system, monitoring and control capabilities are needed for liquid level, solution density, solution temperature, and vapor space pressure.

5. For filters associated with the offgas treatment system, monitoring and control capabilities shall be provided for the inlet vapor phase temperature, humidity, and pressure drop across filter unit.

6. For exhaust devices (e.g., fans, ejectors, or vacuum pumps). associated with the offgas treatment system, monitoring and control capabilities shall be provided for the inlet vapor phase temperature, inlet vapor phase absolute pressure, treated offgas discharge flowrate, and equipment operating parameters specific to the selected exhaust devices (e.g., rpms of exhaust fan, fan motor bearings temperature, etc.).

3.2.1.6.5 Monitor Chemical Storage. Chemical solution storage vessels shall have liquid level monitoring and controls to alert personnel to conditions where the vessel contents are at the minimum or maximum operating conditions.

3.2.1.7 Facility Hazard Category. The facility hazards category for the IPM shall be HC 2 per DOE Standard, DOE-STD-1027-92. (Function 4.2.2.3.2)

Basis: The calculation of hazard category per the DOE standard is provided in Appendix I, September 1994 Draft, of the *TWRS Facility Configuration Study*, WHC-SD-WM-ES-295, Rev. 0 (Boomer et al. 1994). Hazard category is independent of design. It is a function of the feed specification and required throughput. Facility Hazard Categories are defined in DOE Order 5480.23 and their interpretation and guidelines are provided in DOE-STD-1027-92.

3.2.1.8 Facility Design Life. The facility minimum design life shall be 40 years for the IPM facility and less than 40 years for replaceable components.

Basis: *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1994) milestone M-50-02 specifies "Start hot operations of the LLW pretreatment facility to remove cesium and strontium and shall commence in December 2004." Milestone M-50-00 states "complete pretreatment processing of Hanford tank waste, December 2028." A 40-year design life is considered reasonable as the first estimate (Function 4.2.2.3.2).

Issue 1: The facility design life has not been finalized. The appropriate facility design life must be determined taking into consideration economic factors and required Tri-Party Agreement schedules and documented for reference. Individual equipment components must be evaluated separately.

Required Analysis: A trade study must document the factors considered and the design life selected for the project.

3.2.1.9 Decontamination and Decommissioning. The design of the IPM shall facilitate decontamination so that the facility can be decommissioned at a future date. Guidance for process equipment design to facilitate eventual decommissioning shall be obtained from American National Standards Institute (ANSI) N300-1975, *Design Criteria for Decommissioning of Nuclear Fuel Reprocessing Plants* (ANSI 1975).

3.2.2 System Capability Relationships

TBD.

3.2.3 External Interface Requirements

3.2.3.1 IPM Site Location. The pretreatment, LLW and HLW treatment facilities shall be located in a TWRS Treatment Complex within the 200 E Area. This location is defined as being east of Baltimore Avenue, north and/or south of 4th Street, and west of PUREX (Function 4.2.2.4.1 P5).

Basis: *TWRS Site Evaluation Report*, WHC-SD-WM-SE-021, Draft (WHC 1995).

3.2.3.2 Site Boundary. A site boundary, consistent with the draft Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS) shall be used. The site boundaries for the TWRS EIS will be as follows:

North	Columbia River (1/4 mile from bank per REACH EIS)
East	Columbia River (1/4 mile from bank per REACH EIS)
South	A line running west from the Columbia River, just north of the Washington Public Power Supply System leased area, through the Wye Barricade to Highway 240
West	Highway 240 and Highway 24.

3.2.3.3 Radioactive Airborne Emissions. The following constraints shall be applied to the IPM project.

3.2.3.3.1 Radioactive airborne emissions from any DOE facility shall not exceed those amounts that would cause any member of the public to receive, in any given year, an effective dose equivalent (EDE) to 10 millirem per year. Dose limits are the effective dose equivalent to individuals as specified in DOE Order 5400.5, Chapter II (1b), 40 CFR 61.92, and WAC 246-247. (Function 4.2.2.4.4 P3).

3.2.3.3.2 The use of best available radionuclide control technology (BARCT) is required for the construction, installation of establishment of a new source of radionuclide emissions subject to those requirements per WAC 246-247 (Function 4.2.2.4.4 P4).

3.2.3.3.3 Radionuclide emission rates must be continuously measured at all stacks or vents with a potential to discharge radionuclides into the air in quantities that could cause an EDE to the hypothetical, maximally exposed offsite individual in excess of 1 percent of the 10 millirem per year standard (Function 4.2.2.4.4 P5).

Basis: The emission of radioactive and nonradioactive must be kept as low as reasonably achievable (ALARA) and treated to meet airborne effluent discharge limits. Preliminary dose calculations have been performed and provide a total dose expected from air emissions to be 0.7 mrem/yr based on *Preliminary Offsite Dose Calculations for Tank Waste Remediation System Activities* (Colby 1994). This value represents the total dose resulting from tritium (^{3}H), carbon-14 (^{14}C), and iodine-129 (^{129}I) during routine operations. This dose rate is intended to represent emissions from Zone I areas of the facility which is the primary contributor to the total dose received by the maximally exposed individual.

3.2.3.3.4 WAC-173-480. Ambient and general standards for radionuclide emissions are located in WAC-173-480, 040, and 050.

3.2.3.3.5 Emissions Filtration and Treatment, Required Equipment. High-efficiency particulate air (HEPA) filtration requirements are located in *Environmental Compliance*, WHC-CM-7-5 (WHC 1994b), 2.0 Air Quality, 2.5.5.1.

3.2.3.4 Nonradioactive Airborne Emissions. The following constraints shall be applied to the IPM project.

3.2.3.4.1 The use of best available control technology (BACT) and best available control technology for air toxics (T-BACT) is required for the construction, installation, or establishment of a new source of nonradioactive emissions subject to those requirements. Air emission calculations shall be performed to support the BACT/BARCT analysis (WAC 173-400 and 173-460).

3.2.3.4.2 The national primary and/or secondary ambient air quality standards for the following components can be found in the following regulations:

Sulfur oxides	40 CFR 50.4	(Function 4.2.2.4.4)
Sulfur oxides	40 CFR 50.5	(Function 4.2.2.3 C10)
Particulate matter	40 CFR 50.6	(Function 4.2.2.3 C11)
Carbon monoxide	40 CFR 50.8	(Function 4.2.2.4 C12)
Ozone	40 CFR 50.9	(Function 4.2.2.4 C13)

3.2.3.4.3 The following regulations contain constraints associated with organic emissions, controls, and other nonradioactive airborne emissions and are applicable to this project:

40 CFR 264.1032	(Function 4.2.2.4 C29)
40 CFR 264.1033(a)	(Function 4.2.2.4 C30)
40 CFR 264.1033(b)	(Function 4.2.2.4 C31)
40 CFR 264.1033(c)	(Function 4.2.2.4 C32)
40 CFR 264.1033(g)	(Function 4.2.2.4 C33)
40 CFR 264.1033(h)	(Function 4.2.2.4 C34)
40 CFR 264.1033(k)	(Function 4.2.2.4 C35)

3.2.3.5 Liquid Effluents. Liquid effluents generated by the IPM system shall meet the following requirements:

3.2.3.5.1 The waste stream shall be characterized to the degree established in the ETF *Resource Conservation and Recovery Act of 1976* (RCRA) Part B Permit. Analytical procedures used must be consistent with RCRA waste analysis plans.

3.2.3.5.2 The absorbed radiation dose to a hypothetical individual at the site boundary shall not increase over permitted levels without a modification to the Radionuclide Air

Emission Program (RAEP) permit. Influent concentrations must remain low enough such that this remains true. Radionuclides which have not previously been accounted for, may also force a permit reevaluation.

Basis: Washington State Department of Health (DOH) regulations. Also, see Table 2-1 for applicable WAC sections.

3.2.3.5.3 Only the waste codes listed in the Delisting Petition and the RCRA permit can be accepted for treatment at the Effluent Treatment Facility (ETF), unless the permit and the Delisting Petition are modified.

Basis: The ETF is limited by RCRA regulations to treat only those waste streams containing constituents that have been demonstrated to be treatable. The Delisting Petition to the EPA is the primary document controlling what is considered treatable. This document can be updated to reflect an expansion of the treatment envelope.

3.2.3.5.4 Liquid effluents shall be discharged to the Liquid Effluent Retention Facility (LERF) and/or the Effluent Treatment Facility (ETF) and shall meet the waste acceptance criteria for these facilities. (Function 4.2.2.3.2.4).

Waste Acceptance Criteria based on operability parameters for LERF and ETF (Basis: *Acceptance of Feed Streams for Storage and Treatment at the LERF/ETF*, WHC-SD-ETF-WAC-001 (McDonald 1994):

1. No separable organics. Basis: Physical Limitation of ultraviolet/ozonation (UV/OX). The UV/OX system is designed to treat dissolved organics in concentrations that generally do not exceed 100 to 300 ppm.

2. Minimize colloidal matter to protect filters in the ETF from plugging. Basis: Physical limitation of the rough and fine filters.

3. Minimize concentrations of scale forming compounds, (e.g., calcium sulfate, calcium phosphate, and metal silicates). Basis: Physical limitations of the UV/OX and Reverse Osmosis (RO). Note that silicate concentrations in excess of 0.001 molar fed to the RO system could foul the membranes. Also, the RO membranes are only capable of handling influent dissolved solid concentrations of up to about 500 ppm. Concentrations in excess of this will likely foul the second stage of the RO membranes.

4. Minimize concentrations of corrosive constituents, such as chloride and fluoride. Basis: Physical limitation of the ETF evaporator and dryer. In sufficient concentrations, these constituents can corrode the ETF evaporator and dryer.

5. Minimize concentrations of constituents that can absorb UV light to the extent destruction of targeted organics is significantly compromised. Basis: Physical limitations of the UV/OX system. Nitrate and sulfide are two such constituents. For example, proof-of-principle testing by the Japan Gas Company found hydrogen sulfide forms a milky light-absorbing substance when subjected to ultraviolet light oxidation.

6. Significant concentrations of neutral radionuclide species cannot be accepted by the LERF and ETF without jeopardizing compliance with discharge requirements for radionuclides (0.04 times the Derived Concentration Guidelines) per section 8.4.2.1 of *Environmental Compliance*, WHC-CM-7-5 (WHC 1994b). Plutonium and Ruthenium are known to form such neutral species. Basis: Neutral species have lower decontamination factors primarily because the IX system is only effective on ionic species.The LETF is not currently designed to handle streams with elevated levels of volatile radionuclides.

3.2.3.5.5 Liquid Effluent released to the ground shall not exceed 20,000 curies tritrium per year.

Basis: Section 8.4.2.3.1.e of *Environmental Compliance*, WHC-CM-7-5 (WHC 1994b). This is considered extremely unlikely because there is an estimated 3,300 curies in the tank farm system. NEED to check BASIS for number.

3.2.3.5.6 Groundwater Monitoring. The extent of groundwater monitoring will be determined by the permit requirements. Groundwater monitoring will be in accordance with WAC 173-303-645(8) and other applicable regulations. Any required monitoring will be performed by groundwater management.

3.2.3.6 Solid Waste Management. Solid waste generated by the IPM system shall meet the following requirements.

3.2.3.6.1 Waste generation shall be controlled, reduced, segregated, and minimized in accordance with DOE Order 5820.2A, Chapter III, 3.c.E (Function 4.2.2.4 C70).

3.2.3.6.2 Transfer of solid radioactive waste to the Hanford Site Solid Waste program for dispositioning shall be in accordance with criteria specified in the *Hanford Site Solid Waste Acceptance Criteria*, WHC-EP-0063-4 (Willis 1993) and *Hazardous Materials Packaging and Shipping,* WHC-CM-2-14 (WHC 1993). The facility design shall be capable of segregating and packaging the categories of waste generated from pretreatment processing. Once separated, it is recommended that the solid waste be packaged into 208-L (55-gal) drums or boxes (5 ft x 5 ft x 9 ft). The exterior of all waste packages must not be smearable above 220 dpm/100 cm^2 for alpha and 2,200 dpm/100 cm^2 for beta-gamma per *Hanford Site Solid Waste Acceptance Criteria*, WHC-EP-0063-4 (Willis 1993). (Function 4.2.2.4.4 P8).

3.2.3.7 Hazardous Waste Management. A waste management plan is required (DOE Order 5820.2A) to be developed for facilities that produce radioactive waste and mixed waste (containing both hazardous and radioactive waste components). Hazardous waste is regulated in accordance with the *Resource Conservation and Recovery Act of 1976* (RCRA) and the Washington Administrative Code (WAC) 173-303-630, Dangerous Waste Regulations. Hazardous Waste constraints identified in 40 CFR 264 are redundant to WHC-173-303-630. (Function 4.2.2.4.4).

3.2.3.8 Closure of Facility. The IPM shall follow the constraints of the following:

WAC 173-303-640, "Tank System," (8) Closure and Post Closure.

WAC 173-303-665 (6)(a) (Function 4.2.2.4 C88).

WAC 173-303-610, Closure and Post Closure, especially subsections (2) through (6).

3.2.4 Physical Characteristics.

3.2.4.1 Facility Design and Shielding Criteria. Guidelines for radiological design are provided in *Radiological Design Guide*, WHC-SD-GN-DGS-30011 (WHC 1994c). The shielding design criteria in Table 3-2 are summarized from *Radiological Design Guide*, Section 7.0, and shall be used to determine the shielding requirements of different areas in the facility. Shielding shall be designed to limit the total whole body dose to less than 5 mSv per year. The source term used for shielding design will be provided by WHC.

Table 3-2. Shield Design Criteria.

Zone category	Access time allowed	Maximum (mSv/h)	Maximum (mrem/h)
Uncontrolled area	Fulltime	0.5	0.05
Controlled Area			
1	Fulltime	2.5	0.25
2	Less than 1 h/day	20	2.0
3	Less than 1 h/week	100	10.0
4	Less than 10 h/yr	500	50.0
5	No normal access permitted	>500	>50

Note: For design purposes the dose due to neutrons should be calculated by doubling the neutron quality factors (DOE Order 5480.11).

3.2.4.2 Support Structure(s) and Systems. Support services in the form of emergency power, uninterruptible power supply (UPS), process steam and condensate collection system, regulated process facility entry, maintenance and repair, supply and exhaust air, HPS vacuum system, cold chemical feed, process ventilation system, process cooling water system, process chilled water system, fire water system, solid waste handling, and the collection and handling of radioactive and non-radioactive liquid wastes shall be provided as part of the facility. See Table 3-3 for Support Function Definition. All shared services will be provided by the LLWVP project.

Basis: TWRS Process Support and Infrastructure Definition.

Issue: The support system definitions and identification as a shared or dedicated function is the subject of the trade study *TWRS Process Support and Infrastructure Definition* currently being prepared for initial reviews. All requirements which follow have been derived from this study and must be updated to reflect the final conclusions of the report.

Required Analysis: Review and approval of the trade study *TWRS Process Support and Infrastructure Definition* and allocation of shared support services to the appropriate System Engineering function and project.

3.2.4.2.1 Waste Condensate Collection System. The Waste Condensate Collection System shall be a dedicated system located adjacent to the IPM facility. The function of the condensate collection system is to receive condensate drains from in-cell evaporators to condensate collection tanks, where chemical adjustments are made. The condensed water shall flow by gravity to the condensate collection tanks.

3.2.4.2.2 Process Steam and Condensate System. A dedicated process steam and condensate system shall be provided by the IPM project. The system shall be designed as a closed, primary steam distribution loop.

3.2.4.2.3 Collection and Handling of Potentially Radioactive Liquid Waste. The project shall provide collection and handling of potentially radioactive liquid effluents. The system shall be capable of analyzing and diverting potentially contaminated effluent streams to suitable retention facilities. If analyses show the stream to be radioactive, the liquid waste shall be transferred to a radioactive process waste collection tank for processing. If the analyses show the stream to be non-radioactive, the liquid waste is transferred to the non-radioactive waste collection tanks for treatment and disposal.

3.2.4.2.4 Process Cooling Water System. The dedicated process cooling water system shall be provided by the IPM project. The process cooling water system shall be a closed, recirculating cooling water loop which cools in-cell radioactive and potentially radioactive streams. The system also provides cooling for the offgas.

Table 3-3. Support Function Definition. (Table derived from early draft of *TWRS Process Support and Infrastructure Definition*) (2 sheets)

Function description	Location/provider	Shared versus dedicated
Waste condensate collection system	User facility (condensate collection annex)/IPM	Dedicated
Process steam and condensate system	User facility/IPM	Dedicated
Collect and handle potentially radioactive liquid waste	User facility/IPM	Dedicated
Process cooling water system	User facility/IPM	Dedicated
Process chilled water system	User facility/IPM	Dedicated
Process facility fire water system	Water pumphouse/IPM	Dedicated/Grouped
Process facility vent system	User facility/IPM	Dedicated
Supply air treatment system	User facility/IPM	Dedicated
Exhaust air treatment system	User facility (fan/filter annex)/IPM	Dedicated
Cold chemical vent system	Bulk cold chemical building/LLWVP	Dedicated to bulk cold chemical building
Cold chemical feed system	User facility/IPM	Dedicated
Cold chemical supply	Bulk cold chemical building/LLWVP	Shared
Collection and handling of solid wastes	User facility/IPM	Dedicated
Emergency power system	Emergency generator building/IPM	Dedicated
Uninterrupted DC power system	User facility/IPM	Dedicated
Personnel Protection System	User facility/IPM	Dedicated
Regulated facility entry	User facility/IPM	Dedicated
Maintenance and repair (master-slave manipulators and others)	User facility/IPM	Dedicated
Collect and handle non-radioactive liquid wastes	Bulk cold chemical building and mechanical utilities building/LLWVP	Shared
Cooling tower water	Cooling tower/LLWVP	Shared
Process water and demineralized water system	Mechanical utilities building/LLWVP	Shared
Raw water system	Water pumphouse/LLWVP	Shared
Sanitary sewer system	Treatment complex site/LLWVP	Shared

Table 3-3. Support Function Definition. (Table derived from early draft of *TWRS Process Support and Infrastructure Definition*) (2 sheets)

Function description	Location/provider	Shared versus dedicated
Sanitary water system	Water pumphouse/LLWVP	Shared
Tank Waste Remediation System treatment complex site fire water system	Water pumphouse/LLWVP	Shared (among non-processing facilities)
Utility steam system	Mechanical utilities building/LLWVP	Shared
Heating, venting and air conditioning chilled water system	Mechanical utilities building/LLWVP	Shared
Compressed air system	Mechanical utilities building/LLWVP	Shared
Normal AC power system	Switchgear building/LLWVP	Shared
Process facility operations control system	Regulated treatment complex entry building/LLWVP	Shared
Sample analysis	Analytical facility/LLWVP	Shared
Major equipment assembly	Assembly and fabrication shop/LLWVP	Shared
Spare parts fabrication	Assembly and fabrication shop/LLWVP	Shared
Telecommunications system	Emergency response center/LLWVP	Shared
Regulated Tank Waste Remediation System treatment complex entry	Regulated Tank Waste Remediation System complex entry building/LLWVP	Shared
Treatment Complex Management System	Operations support/LLWVP building/LLWVP	Shared
Employee Support System	Regulated Tank Waste Remediation System complex entry building/LLWVP	Shared
Shipping and Receiving System, Warehousing and Storage System, Service Yard	Warehouses/LLWVP	Shared
Emergency Shutdown	Emergency Response Center/LLWVP	Shared

IPM = Initial Pretreatment Module
LLWVP = Low-Level Waste Vitrification Plant.

3.2.4.2.5 Process Chilled Water System. TBD.

3.2.4.2.6 Process Facility Fire Water System. A dedicated fire water system shall be provided by the IPM facility. The fire protection system shall meet the requirements of National Electrical Code (NFPA 70-1990), National Fire Codes (NFPA 1990), DOE Order 5480.7A, and DOE Order 6430.1A. The Process Facility Fire Water System shall include storage tanks, pumps, electric heaters, headers and distribution piping. Diesel driven fire water pumps shall be provided as a backup to the main electric motor driven pumps.

3.2.4.2.7 Process Facility Ventilation System. A separate process ventilation system shall be provided by the IPM for vapors and offgas from process vessels. These gases shall be collected in a common header, treated, and routed to the facility exhaust ventilation system. The process ventilation system shall be capable of decontaminating the vapors and offgas so that component concentrations, following filtration in the facility exhaust system, shall meet requirements for stack release to an uncontrolled area as defined in *Environmental Compliance*, WHC-CM-7-5 (WHC 1994b).

The purpose of this system is to prevent hydrogen buildup in vessels due to radiolysis, decontaminate the gases for release to the facility exhaust system, and maintain a differential pressure sufficient to maintain containment. Process vessels shall be maintained at a pressure less than that of the ambient atmosphere, and backflow prevention devices shall be provided at each contaminated-noncontaminated material interface boundary.

The hydrogen generation rates in the process vessels shall be calculated as part of the design process, and, if any possibility of reaching explosive concentrations exists, a monitoring and associated concentration control system shall be provided.

3.2.4.2.8 Supply Air Treatment System. The Supply Air Treatment System is a dedicated annexed system. This system is grouped with the HVAC Zone II and III Exhaust Air Treatment system on the roof of the process facilities. A dedicated system close coupled to each facility allows for better operational control and increases the reliability of the system.

3.2.4.2.9 Exhaust Air Treatment System. The IPM project shall provide an Exhaust Air Treatment System that filters, samples, and monitors the exhaust air. This system is a dedicated annexed system, which allows for better operational control and increases overall reliability of the system. Close coupling is required to conform to DOE Order 6430.1A requirements that the filtration system be as close as possible to the source of contamination.

3.2.4.2.10 Cold Chemical Vent System. The cold chemical vent system shall be provided by the Immobilize and Dispose LLW Function. The primary function of the cold chemical vent system is to provide vapor control on the overhead vent lines from the cold chemicals storage and makeup tanks in the Bulk Cold Chemical Building.

3.2.4.2.11 Collect and Handle Solid Waste. The requirements for solid waste management are found in Section 3.2.3.6.

3.2.4.2.12 Emergency Power System. An Emergency Power System shall be provided by the IPM. The emergency power system shall provide power to those functions required to maintain confinement and bring the IPM facility into a safe shutdown condition in the event of a loss of normal AC power. Switchgear, motor control centers, batteries, and UPSs and systems will be located as required throughout the complex.

3.2.4.2.13 Uninterruptible Power Supply System. The IPM shall provide a UPS system close to the equipment items requiring UPS support. The UPS system provides continuous power to equipment requiring continuous power during short duration power outages. The system consists of rectifiers/battery chargers, inverters, switching components and batteries.

3.2.4.2.14 Personnel Protection System. The Personnel Protection System is a dedicated internal system provided by the IPM. The Personnel Protection System provides for worker safety within the TWRS Treatment Complex. This system includes emergency exits, fire walls, shield walls, air locks, change areas, step off pads, alarms, radiation monitors, air samplers, and other items required to assure worker safety. This system is distributed to all areas within the complex that may pose a threat to the worker population.

3.2.4.2.15 Maintenance and Repair. Process building maintenance shall be performed by personnel that are housed in an operator support building shared with the other TWRS processing functions (e.g. LLW and HLW vitrification). The shared facility maintenance building shall be provided by the Immobilize and Dispose of LLW function.

Equipment Maintenance and Repair. Dedicated maintenance and repair functions shall be provided for (1) failed non-contaminated equipment, (2) failed contaminated equipment, (3) master slave manipulators: radioactive and non-radioactive portions.

3.2.4.2.16 Collect and Handle Non-radioactive Liquid Wastes. Non-radioactive liquid effluents produced as the result of facility and processing operations shall be minimized. The non-radioactive liquid effluents shall be collected and handled in a utilities building shared with the other TWRS processing functions and provided by the Immobilize and Dispose LLW function. The liquid wastes must be analyzed and validated as non-radioactive before transfer to the Collect and Handle Non-radioactive Liquid Waste System.

3.2.4.2.17 Cooling Tower Water. The cooling tower water system shall be a shared, close-external system provided by the Immobilize and Dispose LLW function. The Cooling Tower Water System includes the cooling tower, cooling tower water circulation pumps, inhibitor addition pump, and distribution piping for the various users.

3.2.4.2.18 Process Water and Demineralized Water System. The Process Water and the Demineralized Water shall be a shared, close-external subsystem provided by the Immobilize and Dispose LLW function. A single location shall be provided for metering and distributing water for use in the IPM facility.

3.2.4.2.19 Sanitary and Raw Water System. Raw and sanitary water systems shall be shared utilities with the other TWRS processing functions and shall be provided via a shared water pumphouse allocated to the Immobilize and Dispose LLW function. Sanitary water (potable) water shall be separated from raw (nonpotable) water by the design criteria as stated in DOE Order 6430.1A. Sanitary water shall be used to supply the plant facilities water needs (e.g. domestic water). Water shall be provided for process equipment needs. A backup water supply shall be available to meet process equipment requirements. Raw water shall be supplied to the facility for fire protection purposes.

3.2.4.2.20 Sanitary Sewer System. The sanitary sewer shall be routed to a shared collection and handling system provided by Immobilize and Dispose LLW function. The system consists of sewer collection mains and a sewage lift station. The system discharges the domestic sewage to the 200 Area Sanitary Sewer System. The portion of the sanitary sewer system within the IPM shall be designed for a 7-day, 24-h, 3 work-shift basis, and shall be sized for the maximum number of people on 1 shift.

3.2.4.2.21 Utility Steam System. The utility steam system shall be a shared, close-external system provided by the Immobilize and Dispose LLW function. The utility steam system consists of two shared electric utility steam generators and their associated equipment, and the condensate collection system for condensate trapped from steam distribution piping.

3.2.4.2.22 Cold Chemical Supply System. The cold chemical supply system shall be a shared, close-external system provided by the Immobilize and Dispose LLW function. This system provides the cold chemical receipt, storage, preparation, and distribution functions for the project. This system is sized to provide a minimum 30 day supply of cold chemicals. The prepared chemical solutions are transferred from the makeup tanks in a Bulk Cold Chemical Building to the cold chemical feed tanks in the IPM facility. The IPM shall provide intermediate storage for the chemicals needed to support the in-cell process equipment and decontamination facilities, and provide backflow protection for the cold chemicals.

3.2.4.2.23 Cold Chemical Feed System. The Cold Chemical Feed System is a dedicated system located in the process facilities for radiological protection. This system provides intermediate storage for the chemicals needed to support the process equipment and decontamination facilities.

3.2.4.2.24 Heating, Ventilation, and Air Conditioning (HVAC) System. An HVAC system or systems shall be provided to ensure safe operation of the facility. The HVAC system shall be designed to maintain airflow from noncontaminated to progressively more contaminated areas. Consideration shall be given to providing separate HVAC supply systems for contaminated and noncontaminated areas. The HVAC system shall meet applicable requirements in DOE Orders 6430.1A, *General Design Criteria* (DOE 1989); 5480.11, *Radiation Protection for Occupational Workers* (DOE 1988); RL 5480.11A (DOE-RL 1986); DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, and all other applicable federal, state, and local regulations. Sufficient redundancy and/or spare capacity shall be provided to ensure adequate ventilation during normal operation and design basis accident conditions.

3.2.4.2.25 Compressed Air System. The Compressed Air System shall be a shared, close-external system provided by the Immobilize and Dispose LLW function. Distribution of the compressed air system for facility use shall be provided by the IPM project. The system provides instrument air for pneumatically controlled components; plant air for spargers, jets, and general maintenance use; and breathing air. The IPM shall supply breathing air from bottles as needed.

3.2.4.2.26 Normal AC Power System. The normal AC power system will distribute AC power throughout the TWRS Treatment Complex and originates at an offsite 230 kV switchyard with a capacity to serve multiple facilities. Power will be distributed from the switchyard at 34.5 kV to intermediate substations dedicated to various TWRS complexes. A single substation will be located at the TWRS Waste Treatment Complex (Switchgear Building) to transform the 34.5 kV feed to 13.8 kV normal AC power. The IPM facilities shall utilize unit substations to transform the 13.8 kV distribution to utilization voltages of 13.8 and 4.151 kV, and 480 V, depending on specific needs.

3.2.4.2.27 Process Facility Operator Control System. The IPM shall provide a distributive control system (DCS) system that must interface with the centralized control system provided by the Immobilize and Dispose LLW function. The centralized control system monitors and controls remote operations, process operations, etc. The operational controls, except for the Safety Class 1 safe shutdown portion of the system, are located in the centralized control room. The Safety Class 1 safe shutdown portion of the system is located in the Emergency Response Control Building to be provided by the Immobilize and Dispose LLW function.

The DCS shall be a special-purpose, functionally distributed, microprocessor-based system with hierarchical functions supervised or handled by the host computer in the centralized control room. The host computer shall be provided by the Immobilize and Dispose Function. The interface requirements to the centralized control system will be defined as part of the Immobilize and Dispose LLW function. The design of the DCS shall comply with these interface requirements.

The DCS shall monitor and control the facility process operations, HVAC, and support services; provide product quality control; and process manual requests and data input. Standard vendor-supplied software shall be used and shall be capable of calling up real-time displays and historical trends. The distributed microprocessors shall have execution speeds, scan rates, transmission rates, and loadings appropriate to ensure control of the facility or process.

The installed spare capacity of system hardware such as input, output, memory, peripheral, and additional DCS devices shall be a minimum of 25 percent.

3.2.4.2.28 Sample Analysis. The sample analysis is a shared function to be provided by the Immobilize and Dispose LLW function. The sample analysis function is required to collect and analyze process liquids and gas samples taken from the sample cells and/or other collection devices. The sample analysis function also supports limited analyses of cold chemicals and provides for environmental monitoring, effluent monitoring, health and radiation monitoring, and examination of smear test samples. Sample analysis equipment is required to perform sample quality tests, dry solids work, dissolutions, anion analyses, elemental/isotope analyses, separations, and dilutions within an analytical cell. Glove boxes, hoods, and other personnel protection devices are considered to be part of this system. Sample schedules shall be provided by the project.

3.2.4.2.29 Major Equipment Assembly. Interim Failed Equipment Storage. Dedicated space shall be provided to store failed radioactive equipment prior to removal from the facility. The space shall be sufficient to minimize adverse impact on plant operations.

3.2.4.2.30 Spare Parts Fabrication. The spare Parts Fabrication function is a shared (not distance constrained) function. Operability and maintainability is the prime defining consideration. This facility needs to be readily accessible by rail and motor vehicle, and, therefore, is a candidate for being located in an existing Hanford Site facility.

3.2.4.2.31 Telecommunications System. The telecommunications system is a shared, close-external system and shall be provided by the Immobilize and Dispose LLW, function 4.2.2.4. The system consists of all equipment required to provide internal and external communications functions. The external telecommunications system will provided for telephone, emergency response and data transfer into and out of the TWRS Treatment Complex, while the internal telecommunications system will provide for communications within the complex. This system includes voice, video, spectrum-dependent communications and data communications required to support facility operations, maintenance, management and emergency response.

Land based trunk lines will enter the Treatment Complex at a single location and be routed to the telecommunications room in the Emergency Response Center. Distribution equipment will then route both hard wired and wireless communications to the various facilities within the complex.

3.2.4.2.32 Regulated TWRS Complex Entry Building. The Regulated TWRS Treatment Complex Entry System shall be a shared, close-external system provided by the Immobilize and Dispose LLW function. The regulated entry building controls the entry to and exit from the TWRS Treatment Complex and is composed of unregulated change areas, lockers, showers, and radiation monitors.

3.2.4.2.33 Regulated Facility Entry. The Regulated Facility Entry System shall be a dedicated system provided by the IPM. This system shall be grouped with personnel protection equipment in areas close-linked to the facility. The regulated entry system controls the entry to and exit from the IPM that pose a threat of radiological contamination to the worker population. The system shall be composed of step-off pads, regulated change areas, lockers, hand sinks and showers, full-body monitors, hand and foot monitors, and portal monitors.

3.2.4.3 Storage Capability. TBD.

3.2.4.4 Waste Compatibility. The requirements for waste compatibility are located in "Use and Management of Containers," WAC 173-303-630, (4) Compatibility.

3.2.4.5 Waste Packaging. See also requirements for solid waste handling.

3.2.4.5.1 Radioactive Material Packaged for Transportation. Radioactive materials properly packaged for transportation from facilities comprising the IPM shall comply with the following requirement:

- Dose rate limits for radioactive material packaged for onsite transportation are identified in *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements* (Stickney 1988) and shall be used for shipment activities.

3.2.4.6 Secondary Containment. The design, construction, material, capacity, equipment, pipeline, etc., secondary containment requirements are located in the following:

WAC 173-303-640 (4) (b)

WAC 173-303-640 (4) (c)

WAC 173-303-640 (4) (d)

WAC 173-303-640 (4) (e)

WAC 173-303-640 (4) (f)

WAC 173-303-640 (5)

DOE Order 5820.2A, Chapter I, 3.b(2)(b)	(Function 4.2.2.4 C59)
DOE Order 5820.2A, Chapter I, 3.b(2)(d)	(Function 4.2.2.4 C60).

3.2.5 System Quality Factors

3.2.5.1 Reliability, Operability, and Maintainability. Each facility shall utilize remote maintenance features and other appropriate techniques to minimize personnel radiation exposure in accordance with DOE 5481.1B Chapter I, 3.b(2)(j). Four maintenance and operations (M&O) categories shall be used to assist in evaluating the design of the IPM facility. (Function 4.2.2.3.2).

3.2.5.1.1 Fully Remote Maintenance and Operation/Remotely Operated and "No" Maintenance (M&O Categories 1 and 2). Each system or portion of a system having radiation levels greater than 50 mrem/hr contact exposure shall be either (1) remotely maintained and operated or (2) designed to require no maintenance and be remotely operated. However, implementation of no maintenance must be consistent with the requirements of 3.2.8.

Basis: M&O-1 Definition (Reference WHC-SD-WM-ES-295, Appendix H). "Equipment and operational areas falling into this category have radiation levels higher than that which would allow full contact maintenance and operations. Selection of this category should be considered when operational practicalities and economics dictate the need for maintenance and replacement capabilities, while ALARA considerations restrict worker contact. Design for this category should minimize active components. In-cell remote operations may use an in-cell remote crane with an impact wrench, master slave manipulators for light operations in close proximity to shielding windows, and electro-mechanical manipulators. The amount of remote handling equipment is dependent on the operations to be performed."

M&O-2 Definition (Reference WHC-SD-WM-295, Appendix H): "Equipment and operational areas falling into this category have radiation levels higher than that which would allow full contact maintenance and operations. Selection of this category should consider worker exposure as well as operational practicality and economics. Systems and equipment designed for the M&O category have little external contamination potential because they are typically all-welded systems. Moving parts, wear surfaces, gaskets, and stress cycles (e.g., thermal) are minimized. The corrosion potential for all materials must be low and the flowsheet fully demonstrated with no potential for change. "No maintenance" facilities/areas have little or no remote handling equipment installed."

3.2.5.1.2 Limited Contact Maintenance and Operation (M&O Category 3). Each system or portion of a system having radiation levels greater than 0.1 mrem/h to less than or equal to 50 mrem/h shall be designed for limited contact maintenance and operation. Designs shall consider remote removal of radiation sources and decontamination prior to personnel entry.

M&O-3 Definition (Reference WHC-SD-WM-ES-295, Appendix H): "Equipment and operational areas falling into this category have radiation levels higher than that which would allow full contact maintenance and operations. Selection of this category should consider occupational dose, operational practicality and economics which favor design for a limited amount of contact M&O over design for fully remote M&O. Design for this category may include sealed sources in-cell that can be remotely removed with effective contamination control. Personnel entry is then allowed for contact maintenance."

3.2.5.1.3 Full Contact Maintenance and Operation (M&O Category 4). Each system or portion of a system having radiation levels less than or equal to 0.1 mrem/h shall be designed for full contact maintenance and operation.

M&O-4: Full Contact Maintenance and Operation (Reference WHC-SD-WM-ES-295, Appendix H). "Equipment and operations falling into this category have levels of radiation and potential for contamination so low that the area may either be considered uncontrolled, such that full-time access is allocated, or controlled, such that a maximum of 40 h/week of individual worker occupancy is permitted. This corresponds to "uncontrolled radiation areas" and "controlled radiation zone 1 areas". Additionally, levels of contamination are so low as to require no posting, consistent with the criteria presented in DOE N 5480.6."

Basis: *TWRS Facility Configuration Study*, WHC-SD-WM-ES-295, Appendix H, "Maintenance, Operations, and Design Philosophy." A full contact M&O facility has been excluded from further consideration for this facility design based on the shielding analysis provided in WHC-SD-WM-ES-295, Appendix H. Figure 3-4 graphically depicts the M&O Category Selection process and has been reproduced from Appendix H.

3.2.5.2 Availability. The minimum total operating efficiency for the IPM shall be 60 percent.

Basis: TBD.

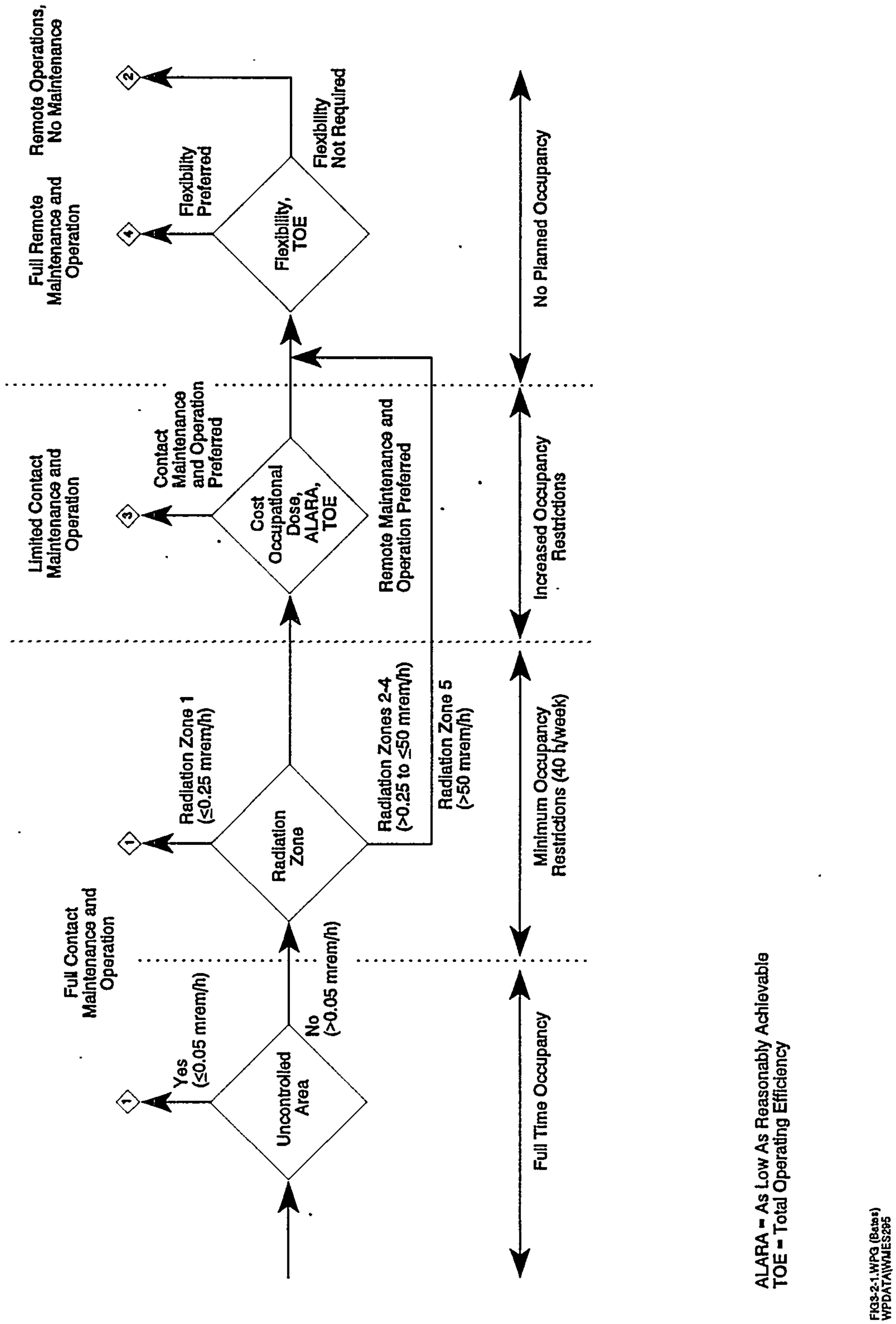
3.2.6 Environmental Conditions

Each system for the IPM shall be designed to meet the requirements for exposure to the following natural and induced environmental conditions:

3.2.6.1 Natural Environments.

3.2.6.1.1 Temperature. Each system shall be operated within the temperature range of TBD.

Figure 3-4. Maintenance and Operations Category Selection.



3.2.6.1.2 Humidity. Each system shall be designed to function with relative humidity ranging from TBD.

3.2.6.1.3 Surface Precipitation. Each system shall be designed to withstand sand and dust concentrations of TBD.

3.2.6.2 Induced Environments.

3.2.6.2.1 Radiation and Chemical. Installed equipment shall be capable of performing their intended function for the duration of their intended useful life with no adverse effects due to the radiological and chemical environment in the system(s) in which they operate.

3.2.7 Flexibility and Expansion

3.2.7.1 Flexibility. The process and facility design shall accommodate changes in the flowsheet throughout the operating life of the facility by a built-in capability to change process equipment (e.g., process flexibility). (Function 4.2.2.3.2 CX).

Basis: DOE Order 6430.1A, section 0110-3 states: "Flexibility is a major design requirement for all facilities except those with highly specialized functions. Even in those special facilities, however, the design shall, to the maximum extent practicable, provide sufficient flexibility to accommodate for programmatic changes or operational modifications."

The duration of the design and construction schedule and the operating life of the facility are considered long enough that new developments in the flowsheet or equipment efficiencies are likely and will need to be incorporated into the plant without the delay of new construction. The degree of flexibility will be determined during conceptual design.

Typically, the following flexibility features are provided:

- Remote equipment installation and removal and the decontamination and decommissioning (D&D) capabilities for remotely maintained equipment and facilities

- Provisions for wall blanks in the process cells for future installation of shielded windows and/or manipulators

- Spare pipe routings

- Spare electrical wall nozzles

- Capability to provide additional process equipment: Flexibility on filter selection for feed clarification to the IX column shall be provided (e.g., cross-flow filtration, pneumatic hydropulse (PHP), sand filter, etc.)

- Spare nozzles on process vessels.

3.3 DESIGN AND CONSTRUCTION

DOE Order 6430.1A provides general design criteria for the acquisition of the Department of Energy facilities. The general design criteria specified in DOE Order 6430.1A (primarily applicable Division 13 and applicable parts of Section 99) shall be used for the design and construction of the IPM, Project W236-B. Additional specific requirements are identified in the following sections.

3.3.1 Physical Structure, Shielding

The structure and layouts of the facility shall conform to applicable HPS, DOE Order 6430.1A (DOE 1989), National Fire Protection Association (NFPA) codes (NFPA 1990), and the *Uniform Building Code* (ICBO 1988).

Issue 1: The selection of a combined pretreatment and LLW vitrification facility impacts the design of the facility. The decision on the selected facility configuration has not yet been made. This decision is required before the IPM conceptual design is 30 percent complete.

Basis: *Tank Waste Remediation System Facility Configuration System* (Boomer et al. 1994).

Required Analysis: Appropriate requirements related to the selected facility configuration will need to be integrated into the project DRD.

Issue 2: A decision on the allocation of the sludge washing function to the IPM project is required before the IPM conceptual design is 30 percent complete.

Basis: Trade Study, *Sludge Washing*, E/B-SD-W236B-RPT-021.

3.3.2 Materials

3.3.2.1 Toxic Products and Materials.

3.3.2.1.1 40 CFR 761.30(I)(1)(ii). 40 CFR 761.30 (I)(1)(ii) contains requirements for PCB capacitors and releases of PCBs.

3.3.2.1.2 The design shall include provisions required for handling hazardous materials as identified in DOE Order 5480.3.

3.3.3 Nameplates and Product Marking

3.3.3.1 Equipment and Piping Labelling. DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, Chapter XVIII, item C specifies requirements for equipment and piping labelling.

3.3.3.2 Data Standards. Hanford Site standards developed for identification of nameplates and product markings shall be followed and are specified in *Data Standards Administration*, WHC-CM-2-6 (WHC 1994a).

3.3.4 Safety

3.3.4.1 Design Basis Accidents. The project shall be designed to withstand the effects of design basis accidents (DBA), as defined in DOE Order 6430.1A, *General Design Criteria* (DOE 1989), without loss of containment and with confinement of radioactive and toxic materials within allowable limits. Simultaneous occurrences of more than one DBA shall be considered when a joint occurrence (i.e., common-mode failure) is possible.

3.3.4.2 Nuclear Safety.

3.3.4.2.1 Criticality. An assessment of the design shall be made as early as practical to determine if the potential for nuclear criticality exists. The nuclear criticality assessment will be based on a criticality feed composition with elevated fissile material content to determine when the potential for criticality exists and to define criticality controls which may impact the system design. This feed composition will be provided by WHC. When such potential exists, the design of nuclear criticality control provisions, including equipment and procedures, shall meet, as a minimum, the requirements of DOE Orders 5480.5, 5480.24 and ANS 8.1, 8.3, 8.5, 8.7, 8.15 and 8.19 series on Nuclear Criticality Safety as implemented in WHC-CM-4-29. (DOE Order 6430.1A, Section 1300.4).

3.3.4.2.2 Criticality. The IPM will process radioactive waste products that have trace quantities of fissile materials which in their present state are conservatively subcritical. These fissile materials, however undergo processes that could in some cases concentrate the fissile materials or change their geometric configuration or both. An evaluation shall be performed during conceptual design to assess the potential for criticality in the process design. (DOE Order 6430.1A Section 1300-4).

3.3.4.3 Classification of Structures, Components, and Systems. The project design shall comply with the *Management Requirements and Procedures*, WHC-CM-1-3, "Safety Classification of Systems, Components, and Structures," MRP 5.46 (WHC 1991). This Westinghouse Hanford Company (WHC) manual uses a graded approach to safety classification (which includes four categories) of structures, components, and systems.

3.3.4.3.1 Safety Classification. All structures, components, and systems shall be assigned to the appropriate safety class according to the following criteria and methodology, which are based on potential consequence of failure. Items that fall into more than one class shall be assigned to the highest applicable class. The terminology "safety class" or "safety class item" as used in DOE Order 6430.1A, *General Design Criteria* (DOE 1989) is equivalent to and applies only to WHC Safety Class 1. Note that Safety Classes 1, 2, and 3 in DOE Order 6430.1A, "Abbreviations and Glossary" section, are not used to implement the WHC safety classification system and are not equivalent to the WHC safety classification categories.

> **Issue 1:** A site boundary must be assumed for safety classification and implementation of MRP 5.46. See requirement 3.2.3.2. A site boundary assumption has yet to be finalized for all TWRS applications.
>
> **Required Analysis:** Until a final site boundary can be selected, all safety class designations for the system should clearly show where a change in classification is critical to the design of the facility. This shall be provided by the project.

3.3.4.4 Component Failure Analysis. The design shall be such that no single credible component failure or loss of normal power will result in unacceptable safety consequences. Unacceptable safety consequences include the following:

- Fire (other than localized minor fire such as caused by shorting of electrical equipment)
- Explosion
- Criticality

- Instantaneous release of radioactivity from the facility in excess of 5,000 times the derived concentration guide (DCG) values specified in WHC-CM-7-5, *Environmental Compliance*, Appendix A (WHC 1994b) at point of discharge

- Exposure of personnel to ionizing radiation in excess of DOE Order 5480.11, *Radiation Protection for Occupational Workers* (DOE 1988)

- Exposure of personnel to toxic chemical agents in excess of ceiling threshold limit (CTL) value of the American Conference of Governmental Industrial Hygienists.

The effects of component failure, including control and monitoring, and utilities failure (such as power sources, air and vacuum supplies) shall be evaluated for unacceptable consequences.

3.3.4.5 Abnormal Operations. The facility design shall include provisions to monitor and alarm on detection of abnormal conditions such as radioactive particulate release, liquid and gaseous release, abnormal radiation levels, fires, and overheating or pressurization. Process and facility systems shall be designed to ensure safe channeling of energy and material flows (e.g., rupture discs, seal pots, fault-to-ground electrical circuitry, siphon breaks, etc.).

3.3.4.6 Personnel Radiation Exposure. Personnel radiation exposure shall be in accordance with ALARA principles and the following orders:

DOE Order 5400.5 Chapter II, item 2	(Function 4.2.2.4.4. P1)
DOE Order 5820.2A, Chapter 1, 3.C (2)(s)	(Function 4.2.2.4 C67)
DOE RLIP 5480.11, (7)(c)	(Function 4.2.2.4 C108)

3.3.4.7 10 CFR 61.41. 10 CFR 61.41 contains requirements on concentrations of radioactive material which may be released to the environment. (Function 4.2.2.4 C2).

3.3.4.8 Ventilation Systems. The ventilation system provides contamination confinement and functions with the process enclosures to ensure contamination control. This system shall be designed in accordance with DOE Order 6430.1A (DOE 1989), DOE Order 5480.11 (DOE 1988), and DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (DOE 1990).

3.3.4.8.1 DOE Order 5820.2A, Chapter I, 3.b(2)(f). DOE Order 5820.2A, Chapter I, 3.b(2)(f) identifies cases where ventilation and filtration systems are required. (Function 4.2.2.4 C61).

The total volume of air handled shall be that required for conditioning or contamination control, and shall include the infiltration air from the outside. The infiltration of outside air shall be limited by providing tight-fitting doors or airlocks, as appropriate, at the entrances to the building.

Sufficient redundancy and/or spare capacity shall be provided as necessary to ensure adequate ventilation during normal operations and DBA conditions.

3.3.4.9 Ventilation Zones. Definition of the ventilation zones shall be as specified in Table 3-4. The differential pressures specified shall be with respect to atmosphere and shall be considered minimum. Airlocks and other barriers shall be provided as required to separate zones to ensure ventilation balance and contamination control and to maintain pressure differentials.

Table 3-4. Ventilation Zones.

Zone	Minimum DP (in. WG)	Description of typical areas
I - Process Zone	- 1.0	High and potentially high contamination areas.
II - Control Zone	- 0.5	Areas providing access or penetrations to Zone I. Not normally contaminated areas with moderate contamination potential. May be normally or frequently occupied areas.
III - Operating Zone	- 0.25	Not normally contaminated areas with low contamination potential. Normally or frequently occupied areas.
IIIA - Operating Zone	- 0.1	Less contamination potential than Zone III. Minimum DP may not be maintained with outer doors open.
IV - Uncontrolled Access Zone	+ 0.125	Clean areas. Areas where contamination is unacceptable.
Neutral Zone	N/A	Areas not requiring confinement ventilation.

DP = Differential Pressure with respect to atmospheric pressure
N/A = Not Applicable
WG = Water Gage.

Final airborne particulate treatment on all airborne effluents which have the potential to exceed 10 percent of the derived concentration guide-public value on an annual average basis as cited in *Environmental Compliance*, WHC-CM-7-5 (WHC 1994b), shall use a HEPA or equivalent filter.

The adequacy of the filtration system (the number of filtration stages required) shall be determined by analysis to ensure the contamination in the effluents are ALARA and do not exceed the above emission limits.

Design shall provide for measurement of supply and exhaust airflows. Final HEPA filter systems shall include the necessary fire protection provisions to comply with DOE Orders 6430.1A (DOE 1989) and 5480.7 (DOE 1987).

3.3.4.10 Remote Maintenance. (see also Section 3.2.5.1)

3.3.4.10.1 DOE Order 5820.2A, Chapter I, 3.b(2)(j). Requirements for remote maintenance are located in DOE Order 5820.2A, Chapter I, 3.b(2)(j). (Function 4.2.2.4 C64).

3.3.4.11 Fire Protection.

3.3.4.11.1 The requirements for fire protection shall be in accordance with DOE Orders 5480.4, 5480.7A, RL directives RLIP 5480.4c, RLIP 5480.7, WHC-CM-4-41, the NFPA National Fire Codes (including NFPA 101 and 241), and the Uniform Fire Code to the extent that is implemented by WAC 173-303.

3.3.4.11.2 The design for the Fire Protection and Detection System shall comply with the requirements of DOE Order 6430.1A, Sections 1530-3,-4,-5,-6,-7,-8,-9, and -99, Sections 1670-1, -2, -3, and Section 1671-2.

3.3.4.11.3 Lightning protection shall be provided in any facilities containing explosives. {DOE Order 6430.1A, Section 1660-99.4.4}

3.3.4.11.4 The facility shall comply with 29 CFR 1926 and 29 CFR 1910 and NFPA 101. Conformance with NFPA shall be considered to satisfy the site requirements of 29 CFR 1910. (DOE Order 6430.1A, Section 0110-6.1)

3.3.5 Human Engineering

The system shall be designed to be comfortable and natural for humans to operate and maintain. Design considerations shall be given to the guidelines in Mil-Std 1472D, *Human Engineering Design Criteria for Military Systems, Equipment, and Facilities* (DOD 1989).

3.3.6 System Security

3.3.6.1 Plant Security. Exterior telecommunications and alarm systems shall be designed in accordance with DOE Order 6430.1A (DOE 1989). See requirement 3.2.4.2.31, Telecommunications.

3.3.7 Cathodic Protection

Cathodic protection installed by this project needs to be coordinated with existing cathodic protection onsite. Cathodic protection shall be in accordance with DOE Order 5820.2A, Chapter I, 3.b (2)(g) (Function 4.2.2.4 C62).

3.3.8 Tank System

See Section 3.2.3.8, Closure of Facility, for applicable constraints derived from WAC 173-303-640(3).

3.4 PROJECT DOCUMENTATION

Records, documents, and document control pertinent to design functions shall be in accordance with ASME-NQA-1-1989-1A, DOE 5500.7b, DOE-5480.CM, DOE-4700.1, and ANSI/ANS-3.2-88.

3.4.1 Drawings

All drawings prepared for the system shall comply with the Hanford Plant Standards for drawings; SDC-1.3 Preparation and Control of Engineering and Fabrication Drawings.

3.4.2 Technical Manual

Manuals describing the technical operations and maintenance aspects of all equipment provided by the IPM project shall be prepared and provided to the operating and maintenance contractor. Vendor supplied equipment manuals are acceptable as technical manuals.

3.5 PERSONNEL AND TRAINING

The system shall be designed for operation by personnel possessing qualifications in accordance with DOE 5480.20 Chapter IV, and trained in accordance with Chapter I.

Open item: Add FCS facility configuration staffing requirements.

3.6 PRECEDENCE

The hierarchical relationship among requirements specified in section 3 is as follows, excepting those instances where Washington State has been granted regulatory authority by the U.S. Government:

Federal Laws (e.g., CFR)

Revised Code of Washington (RCW) as specified in Washington Administrative Codes (WAC)

Local Ordinances

DOE Orders and Standards

National Consensus Codes and Standards.

This page intentionally left blank.

4.0 QUALITY ASSURANCE PROVISIONS

The IPM Project shall adhere to the applicable requirements of 10 CFR 830, "Nuclear Safety Management, Subpart A, General Provisions, Section 830.120, Quality Assurance Requirements," *Code of Federal Regulations*. In accordance with these requirements, the project shall develop a project specific Quality Assurance Program Plan (QAPP) encompassing the following program elements as applicable to the project:

- Program
- Personnel Training and Qualifications
- Quality Improvement
- Documents and Records
- Work Processes
- Design
- Procurement
- Inspection And Acceptance Testing
- Management Assessment
- Independent Assessment.

Once the QAPP has been approved at the WHC project level, the document shall be submitted to DOE for their approval.

All subcontractors providing services for the IPM Project, such as: architect and engineering (A-E) services, Construction Management (CM) services, and testing services in support of technology development shall be required to have or develop a QAPP compatible with the requirements of 10 CFR 830.120, as specific to the subcontractors area of responsibility. As long as the program is compatible with the above referenced requirements, its bases can be founded in existing consensus standards, such as: ASME NQA-1, 10 CFR 50 Appendix B, and the ISO 9000 series. All subcontractor QAPPs shall be submitted to the IPM WHC Project for review and concurrence.

This page intentionally left blank.

5.0 UNCERTAINTIES

The uncertainties addressed in this section are derived from the functional and requirements analyses of the Pretreat Supernatant function and from adopting the planning basis for the Pretreatment program. The current planning basis is the *Tank Waste Remediation System Functions and Requirements* (DOE/RL 1994a). The TWRS program technical uncertainties for the level one through level four functions, as described in the planning basis, serve as a bridge until the TWRS obtains sufficient information to conduct a formal decision making process. The uncertainties associated with the design requirements for the IPM are primarily technical uncertainties.

These uncertainties are addressed qualitatively only to assess which uncertainties exhibit the greatest influence on the design of the IPM and which issues may not necessarily need resolution until completion of Conceptual Design. The presentation of these uncertainties does not represent a decision analysis or risk assessment which may be required by the program.

5.1 TANK WASTE REMEDIATION SYSTEM PROGRAM UNCERTAINTIES

Key decisions at the TWRS system level have an impact on the IPM project. The TWRS functions and requirements document contains these top level program uncertainties. The *Tank Waste Remediation System Decisions and Risk Assessment*, WHC-EP-0786 (Johnson 1994), contains a discussion of these decisions. The lack of *National Environmental Policy Act of 1976* (NEPA) documentation pertaining to the TWRS program, the decision to retrieve waste from 177 tanks, the NRC classification of SST waste, and the strategy for processing tank wastes are three principal uncertainties at the programmatic level that impact the IPM. Figure 1-2 graphically depicts the selected alternatives/solutions and the key decision blocks for the Pretreat Supernatant function (4.2.2.3.2).

5.1.1 Disposition of Hanford Site Tank Wastes (Decision 4.2) (WHC-EP-0786)

The NEPA evaluation has not been conducted for the actions proposed in the Tri-Party Agreement for disposition of the tank wastes. An environmental impact statement (EIS) addressing the proposed actions for SST wastes and the modifications to the record of decision for the DST wastes is scheduled to be completed October 1996. The TWRS Program is based on the actions proposed in the Tri-Party Agreement for disposition of the tank wastes. The NEPA evaluation could significantly change the scope of the TWRS program.

DOE is managing the uncertainty associated with the TWRS NEPA evaluation in a manner which will minimize impacts to the program. Major tank waste retrieval, pretreatment, treatment and disposal facility acquisitions are not planned until completion of the TWRS NEPA evaluation in order to reduce financial exposure. Organizations which participated in the development of the Tri-Party Agreement are continuing to be actively involved in the TWRS EIS. Their continued support will ensure a consensus is reached on the proposed actions for disposition of the tank wastes.

The TWRS program has assumed the retrieval of waste from all 177 tanks. The program selected this architecture over three other architectures: (1) in situ disposal, (2) partial retrieval and in situ disposal and, (3) continued storage. Retrieval of all tank waste was adopted in December 1991 by DOE as the planning basis for the TWRS (Secretary Decision Concerning the Tank Waste Remediation system, Hanford Site, U.S. DOE Assistant Secretary for the Environmental Restoration and Waste Management memorandum to Manager, DOE Field Office, Richland, Washington). This letter directs the TWRS program to use retrieval of waste from all 177 tanks as planning basis pending NEPA action.

This decision requires the LLW Project to design process equipment for maximum potential flow rates. This requirement places a small amount of risk on the project because facility costs have a low correlation to throughput (also known as the economy of scale). If the NEPA process requires TWRS not retrieve all of the waste, the facilities can easily handle the reduced throughput but, due to the over-designed capacity, the project capital costs will be greater than needed.

5.1.2 NRC Determines Classification of Single-Shell Tank Wastes (Decision 4.2.3.C) (WHC-EP-0786)

If the DOE segregates the largest practical amount of the total site activity attributable to "first-cycle solvent extraction" wastes for disposal as HLW (at least 90 percent of the activity), the U.S. Nuclear Regulatory Commission (NRC) views the residual as "incidental" LLW. The DOE must show that the waste has been processed with the intent to dispose of the HLW in a repository or other appropriate licensed facility leaving behind only a small fraction of moderately radioactive material. The LLW fraction is most of the inventory on a unit mass basis. This segregation satisfies the goals stated in 10 CFR Part 50 Appendix F as incorporated in the *1974 Energy Reorganization Act* and the disposal of the residual material does not require an NRC license.

The LLWVP capacity (140-200 mT/day) is based upon processing the LLW fraction from pretreatment (IPM) of both SST and DST wastes at a 60 percent total operating efficiency over a 14-year period. If the NRC finds that the pretreated supernatant from SST wastes do not comply with the incidental waste criteria, only the LLW fraction from pretreatment of DST wastes would be processed in the LLWVP. The needed capacity (140 to 200 MT/day) of the LLWVP would be reduced to about 50 MT/day. Conversely, the capacity of the HLW vitrification facility would need to be increased for processing all the SST waste and the high-level waste fraction of the DST waste.

5.1.2.1 Background. The Commission completed a review of a rulemaking petition from the States of Washington and Oregon on the subject of the DST wastes and has indicated that it would regard the residual fraction as "incidental" waste. The Commission based its decision on the Commission's understanding that the DOE will assure that the waste: (1) has been processed (or will be further processed) to remove key radionuclides to the maximum extent technically and economically practical; (2) will be incorporated in a solid physical form at a concentration not exceeding the applicable concentration limits for Class C LLW as set out in 10 CFR Part 61; and (3) will be managed, pursuant to the Atomic Energy Act, so that safety requirements comparable to the performance objectives set out in 10 CFR Part 61 are satisfied.

In its ruling for DST waste, the NRC allows for the disposal of 26 MCi of radioactivity. The current TWRS baseline for DST and SST waste estimates the disposal of less than 10 MCi of radioactivity of which greater than 50 percent comes from DST waste. Though TWRS requires a formal classification of the SST, current planning exceeds previous requirements for DST waste and the amount of radioactivity from SST waste is less than the planned from DST waste. See Appendix B for further discussion of incidental waste.

DOE will initiate a dialogue with the NRC concerning the classification of Hanford Site SST wastes. DOE will provide tank waste characterization information and proposed disposition of the SST wastes, consistent with the TWRS EIS, to the NRC, to facilitate their determination of the waste classification. The final exposure to risk will be minimized by targeting a determination of the SST waste classification by July 1996, well before major TWRS facility acquisitions construction starts are initiated.

Concentrations of radionuclides in LLW glass are expected to be comparable to concentrations of other LLW. The total activity of a LLW disposal facility are expected to be comparable to that of other LLW disposal facilities.

5.1.3 Determine Waste Separations Process (Decision 4.2.2.1)(WHC-EP-0786)

The determination of the SST waste classification (Decision 4.2.3.c) may effect the strategy for processing tank wastes, which is to separate these wastes into a low-level and high-level/transuranic waste fractions. If the LLW fraction derived from proposed pretreatment processing of SST wastes is not determined to be incidental from the treatment and disposal of HLW, the decision to separate tank wastes into fractions would need to be revisited.

As a planning basis, DOE has selected relatively simple technologies for separations processing of tank wastes. The waste separations processes selected include separation of sludges/solids from supernatants, washing and leaching of selected components from the sludges/solids to reduce the volume of the vitrified HLW fraction. Cesium would be removed from the tank waste supernatants and wash/leach solutions prior to vitrify these LLW. Some supernatants contain excessive concentrations of strontium and transuranic elements, which would also be removed prior to vitrifying these LLW. Collectively, these waste separations process are referred to a minimum separations.

5.2 SELECTED INITIAL PRETREATMENT MODULE PROJECT UNCERTAINTIES

The architecture uncertainties for the IPM include the selection of a facility concept, tank waste retrieval scenario, degree of radionuclide removal, and characterization requirements. The description of the facility to house the pretreatment process is a significant risk to the TWRS program. The IPM needs to obtain closure on the facility concept to allow facility design and design of engineered structures for the pretreatment for tank waste supernatants.

5.2.1 Issue 1: Determine Supernatant Pretreatment Process Function Facility Integration Concept

The TWRS program evaluated four options: standalone LLW vitrification, LLW vitrification combined with pretreatment, LLW vitrification combined with HLW vitrification, and combined LLW vitrification combined with pretreatment and HLW vitrification (Boomer et al. 1994). The TWRS senior management (Alumkal 1994) determined that the reference separations and LLW vitrification processing functions should be configured in a common, centralized facility. The HLW vitrification function would be located near the other functions, and would be serviced by the same support utilities. For the HLW, continued evaluation of the design concepts that integrate the HLW and LLW vitrification functions in a common facility was recommended. Possible strategies include phased construction of HLW vitrification as a detached facility, HLW vitrification combined with the LLW vitrification function, or conversion of one of the LLW vitrification lines to serve HLW vitrification.

The reference configuration achieves the following objectives: (1) meets Tri-Party Agreement milestones for startup and completion, (2) stays within the Tri-Party Agreement funding allocation during the peak construction period, and (3) has a lower funding profile than the current DOE-RL *Program Implementation Plan* (DOE-RL 1994a).

The TWRS senior management recommendation is currently being reviewed for DOE approval. The impact to the IPM and LLW vitrification projects is considered moderate to high since the inclusion of LLW vitrification and possible design considerations for phased construction of HLW is significant.

5.2.2 Issue 2: Determine IPM Support Functions Integration Concept

Support facilities (i.e., utilities) can be either shared, where one facility serves all plants, or distributed, where individual support facilities are located at each plant. The service utilities which are candidates for consolidation include: change rooms, analytical labs, maintenance support, solid waste handling, utilities (steam, electric, air, water, cooling, demineralized water), liquid effluent treatment, evaporators, stacks, chemical storage, warehousing, and offices, and distributive process control systems. The decision on which facilities are shared versus dedicated is the subject of a trade study expected for completion in February 1995 (V 1.1.3.02.04.01.04, schedule activity L4010401).

This issue also is linked to the facility configuration selection (Issue 2). Since the pretreatment, LLW, and HLW design efforts will be conducted on different schedules, it is important to address the facility integration issues very early in conceptual design. Because conceptual design has already started, risk to the IPM project is considered moderate.

5.2.3 Issue 3: Determine IPM Process Distribution Concept

Two processing concepts have been applied to the Pretreat Supernatant: centralized processing (e.g., one process facility) versus dispersed processing (e.g., processing occurring in several dispersed facilities). Each process concept must meet the same functional requirements of (1) the baseline flowsheet and, (2) completion of the mission per the Tri-Party Agreement definition and schedule. The unit operations in the baseline flowsheet require extensive support functions that would have to be extended to each distributed site. Examples include, utilities, laboratory support, sample transfer, maintenance, cold chemical storage and makeup, feed and product queuing in tanks, road and rail access, control room support, change rooms, etc.

A comparison of these concepts is provided in the *Tank Waste Remediation System Facility Configuration Study* (Boomer et al. 1994). The study concluded that a dispersed processing option was not feasible from cost and operational consideration. The TWRS management decision team (Alumkal 1994) endorsed the pursuit of a centralized facility concept. Additionally, an outside independent review of the TWRS decision recommends no further activities be pursued for the dispersed processing concept. This issue can be closed upon DOE approval on the TWRS management decision (Alumkal 1994). Choice of modular processing would significantly impact the requirements presented in this Design Requirements Document.

5.2.4 Issue 4: Degree of Separations

The potential for release to the environment is a direct function of the inventory of radionuclides in the immobilized LLW. Cesium has been identified as the primary radionuclide requiring separations from the Hanford tank wastes. Candidate cesium removal processes are solvent extraction, precipitation, reverse osmosis, crystallization, and ion exchange. Based upon previous work, it has been assumed that ion exchange will be used to separate cesium from Hanford Site tank wastes. Production scale deployment of all candidate cesium separation processes may not be achievable in all candidate facility concepts (e.g., dispersed supernatant pretreatment modules).

Additional radionuclides (e.g., technetium or strontium) may need to be separated from the Hanford tank wastes to achieve a lightly shielded LLW vitrification facility or achieve the desired environmental performance of the LLW disposal system. Production scale deployment of technetium and strontium separation processes may not be achievable in all candidate facility concepts (e.g., dispersed supernatant pretreatment modules).

The IPM facility shall address these concerns by incorporating design features to reserve the capability to add additional cesium and/or strontium removal processes for operational reasons, or technetium removal to meet the LLW form performance requirements. A similar re-evaluation is necessary after the environmental performance of the LLW disposal system is understood (i.e., preliminary performance assessment may be suitable).

APPENDIX A

PROCESS FEED

Table A-1. Preliminary Flowsheet Feed and Product Compositions (Enhanced Sludge Wash).[1]

Stream name	Supernatant[2]	Separated radionuclides[3]	Pretreated LLW[4]
Liquid components			
Volume, Total Liters	9.49 E+08	3.05 E+06	9.09 E+08
Specific Gravity	1.18 E+00	1.31 E+00	1.18 E+00
Total Mass, (MT)[5]	1.11 E+06	4.00 E+03	1.07 E+06
Al, (MT)	4.12 E+03		4.11 E+03
Fe, (MT)	9.85 E+00		9.85 E+00
Cr, (MT)	1.32 E+02		1.32 E+02
Na, (MT)	7.61 E+04	2.07 E+02	7.84 E+04
Si, (MT)	1.34 E+01		1.34 E+01
P, (MT)	1.67 E+03		1.67 E+03
NO2- and NO3-, (MT)	1.20 E+05	1.53 E+03	1.21 E+05
Cs and Ba, (MCi)[6]	8.88 E+01	8.81 E+01	7.00 E-01
Sr and Y, (MCi)	1.40 E+00	1.39 E-01	1.26 E+00
Tc, (MCi)	3.50 E-02		3.50 E-02
TRU, (MCi)	7.96 E-03		7.96 E-03
Total MCi	9.03 E+01	8.82 E+01	2.00 E+00
Solid components			
Total Mass, (MT)	1.67 E+02	1.36 E+02	1.67 E+00
Al, (MT)	5.95 E+00	4.56 E+00	5.95 E-02
Fe, (MT)	6.84 E+00	5.29 E+00	6.84 E-02
Cr, (MT)	2.67 E-01	2.04 E-01	2.67 E-03
Na, (MT)	1.37 E+00	7.63 E+00	1.37 E-01
Si, (MT)	1.23 E+01	2.36 E+01	1.25 E-01
P, (MT)	1.77 E+00	1.36 E+00	1.77 E-02
NO2- and NO3-, (MT)	7.24 E+00	7.11 E+00	7.24 E-02
Cs and Ba, (MCi)	6.89 E+00	7.23 E-02	6.89 E-02
Sr and Y, (MCi)	1.17 E+00	9.06 E-01	1.17 E-02
Tc, (MCi)	3.93 E-04	6.00 E-05	3.93 E-06
TRU, (MCi)	1.50 E-03	1.16 E-03	1.50 E-05
Total MCi	8.06 E+00	9.79 E-01	8.06 E-02

Table A-1. Preliminary Flowsheet Feed and Product Compositions (Enhanced Sludge Wash).[1]

Notes:

[1]Enhanced sludge wash assumes one 3 *M* NaOH wash and three H_2O washes.

[2]Assumes all supernatants to the pretreat supernatant function must be concentrated (stream 100 from the baseline flowsheet [Orme 1994]).

[3]Concentrated cesium stream to HLW immobilization (stream 230 from the baseline flowsheet).

[4]Cesium depleted stream to LLW immobilization (stream 233 from the baseline flowsheet).

[5]Total mass includes all feed components, but Table 3 only lists selected components of the feed. Therefore, total mass will not balance with component mass given.

[6]Cesium-137 makes up approximately 51% of the combined cesium and barium curies.

Table A-2. Composition of Candidate Initial Feed Sources for Supernatant Pretreatment.

Waste component (gms)	Tank 241-AN-103 (DSS)[1]	Tank 241-AN-104 (DSSF)[2]	Tank 241-AN-105 (DSSF)[2]	Tank 241-AW-101 (DSSF)[1]
Al	2.04E+08	1.14E+08	2.01E+08	1.20E+08
Ca	3.06E+05			1.42E+05
Cd	5.68E+04			
Cl	3.41E+07	2.28E+07	3.64E+07	2.23E+07
CN	1.19E+05			1.15E+05
Cr	3.01E+06	2.04E+06	2.89E+06	6.91E+05
Cu	4.26E+04			1.04E+05
F	2.61E+06			
Fe	2.50E+05	3.38E+04	4.77E+04	
Hg	5.68E+04			
K	5.39E+07	2.16E+07	2.62E+07	1.80E+08
Mg	1.02E+05			2.26E+05
Mn	1.02E+05			1.12E+05
Mo	3.12E+05			2.48E+05
NH_3		3.59E+05	1.45E+06	1.06E+06
NO_2	4.88E+08	2.67E+08	5.13E+08	4.38E+08
NO_3	5.68E+08	5.81E+08	8.26E+08	9.22E+08
Na	1.19E+09	8.35E+08	1.18E+09	9.91E+08
OH	3.46E+08	2.1E+08	2.64E+08	3.71E+08
Pb	2.55E+05			
PO_4	3.29E+06	8.45E+06	8.11E+06	9.07E+06
Si	9.65E+05			
SO_4	5.68E+06	1.98E+07	2.8E+07	4.44E+06
TOC	2.61E+07	1.67E+08	1.99E+08	1.06E+07
U	4.37E+05			9.62E+05
W	7.38E+05			
Zn	1.7E+05			

Table A-2. Composition of Candidate Initial Feed Sources for Supernatant Pretreatment.

Waste component (gms)	Tank 241-AN-103 (DSS)[1]	Tank 241-AN-104 (DSSF)[2]	Tank 241-AN-105 (DSSF)[2]	Tank 241-AW-101 (DSSF)[1]
Radionuclides (curies)				
Cs-137	2.66E+06	2.29E+06	2.15E+06	2.14E+06
Co-60	1.35E+02			
Sr-89/90	4.62E+04	2.98E+04	1.38E+04	4.35E+03
Tc-99	6.03E+02			6.05E+02
I-129	1.88E+00			
Np-237	7.08E-02			
Pu-238	3.49E+00			
Pu-239/240	6.73E+00	3.15E+01	4.44E+01	5.43E+01
Am-241	8.16E+00	3.39E+04	4.78E+04	1.39E+02
Am-243				1.18E+03
Cm-244	1.49E+00			

Notes:
[1]Tank waste composition is from analysis of waste samples as reported in *Tank Characterization Report for Double-Shell Tank 241-AP-105*, WHC-SD-WM-ER-360, Rev. 0 (DeLorenzo 1994).

[2]Tank waste composition is from analysis of waste samples as reported in *Tank Characterization Report for Double-Shell Tank 241-AP-102*, WHC-SD-WM-ER-358, Rev. 0 (DeLorenzo 1994).

Table A-3. Composition of Candidate Initial Feed Sources for Supernatant Pretreatment.

Waste component (gm)	Tank 241-AP-105 DSSF[1]	Tank 241-AP-102 CP waste[2]
Al	3.64E+07	4.85E+07
Ca	2.07E+05	3.34E+05
Cd	5.5E+03	6.14E+03
Cl	7.34E+06	1.21E+07
CN	5.69E+04	1.03E+05
Cr	5.82E+05	2.58E+06
Cu		<1.57E+04
F	4.73E+06	<7.02E+04
Fe	2.05E+04	1.59E+04
Hg	<7.8E+01	<2.09E+01
K	9.64E+07	5.39E+06
Mg	2.83E+04	1.1E+04
Mn		2.33E+05
Mo		<2.78E+05
NH_3	<1.24E+05	1.14E+06
NO_2	1.5E+08	1.59E+08
NO_3	5.13E+08	3.27E+08
Na	5.19E+08	4.26E+08
OH	1.68E+08	3.82E+07
Pb	1.68E+04	1.38E+04
PO_4 P	1.37E+06 9.83E+05	4.85E+07 1.28E+07
Si	4.51E+05	2.01E+03
SO_4	7.53E+06	1.89E+07
TOC	8.55E+06	1.37E+07
U	1.31E+05	1.93E+04
W		
Zn	1.83E+05	<3.95E+04

Table A-3. Composition of Candidate Initial Feed Sources for Supernatant Pretreatment.

Waste component (gm)	Tank 241-AP-105 DSSF[1]	Tank 241-AP-102 CP waste[2]
Radionuclides (curies)		
Cs-137	7.06E+05	9.53E+05
Co-60	<1.35E+02	3.19E+02
Sr-89/90	6.47E+02	6.02E+03
Tc-99	2.17E+02	3.58E+02
I-129	0.473E+00	<0.155E+00
Np-237	0.977E+00	<4.18E+00
Pu-238	<2.79E+00	<0.68E+00
Pu-239/240	0.49E+00	<0.313E+00
Am-241	1.27E+00	1.75E+00
Am-243		
Cm-243/244	<1.98E+00	0.17E+00

Notes:
[1]Tank waste composition is from analysis of waste samples as reported in *Tank Characterization Report for Double-Shell Tank 241-AP-105*, WHC-SD-WM-ER-360, Rev. 0 (DeLorenzo 1994).

[2]Tank waste composition is from analysis of waste samples as reported in *Tank Characterization Report for Double-Shell Tank 241-AP-102*, WHC-SD-WM-ER-358, Rev. 0 (DeLorenzo 1994).

Table A-4. Estimated Composition of Low-Level Waste Glass Based Upon Candidate Initial Feed Sources from Supernatant Pretreatment.

Waste component wt% oxide	16 wt% Na_2O Glass formulation	25 wt% Na_2O Glass formulation
Al	2	3.2
Ca	<0.01	0.015
Cd	<0.01	<0.01
Cr	<0.01	<0.01
Cu	<0.01	<0.01
Fe	<0.01	<0.01
Hg	<0.01	<0.01
K	3.1	4.8
Mg	<0.01	<0.01
Mn	<0.01	<0.01
Mo	<0.01	<0.01
Na	16	25
Pb	<0.01	<0.01
P_2O_5	0.9	1.4
U	<0.01	<0.01
W	<0.01	<0.01
Zn	<0.01	<0.01
Radionuclides (curies/m^3)		
Cs-137	1 (Cs DF required is 555)	1 (Cs DF required is 870)
Sr-89/90	2.2	3.5
Tc-99	0.19	0.3
nci/gm		
Pu-239/240	<0.1	<0.16
Am-241/243	0.38	0.6
Mass of LLW Glass (MT)	7.96E+03	5.09E+03

Note: Estimated mass of LLW glass and waste oxide weight percentages are based upon recycle of caustic solutions used to regenerate the cesium ion exchange column during pretreatment of supernatants. Total mass of LLW glass would increase if recycle of caustic solutions is not conducted.

APPENDIX B

INCIDENTAL WASTE

LETTER

ATTACHMENT 1

LOW-LEVEL WASTE CLASSIFICATION AND SOLIDS/LIQUID SEPARATION CRITERIA FOR INITIAL PRETREATMENT MODULE

BACKGROUND

The U.S. Nuclear Regulatory Commission (NRC) has evaluated the U.S. Department of Energy's (DOE) proposal for pretreatment and disposal of Hanford Site tank wastes. The DOE proposal (Letter, A. J. Rizzo [DOE-RL] to Robert M. Bernero [NRC], March 16, 1989) consisted of ^{137}Cs removal from Neutralized Current Acid Waste (NCAW) and Complexant Concentrate (CC) waste supernatants, and transuranic element removal from Neutralized Cladding Removal Waste (NCRW), Plutonium Finishing Plant 1 (PFP), and NCAW solids, and CC waste. In the proposal, the strontium present in CC waste would not be removed. Removal of technetium was determined not to be practical or cost effective (Rizzo 1989).

In 58 FR 12344, the NRC found that DOE's plans for the handling of double-shell tank (DST) wastes were consistent with their principles of waste decontamination and protection of the public and that "....it would regard the residual fraction as "incidental" waste, based on the Commission's understanding that DOE will assure that the waste: (1) has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical; (2) will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR Part 61; and (3) will be managed, pursuant to the Atomic Energy Act, so that safety requirements comparable to the performance objectives set out in 10 CFR Part 61 are satisfied." (Bernero 1993). A further discussion of the NRC commercial LLW limits and incidental waste limits follow.

NRC COMMERCIAL LLW LIMITS

The requirements for the management of low-level waste are provided in DOE Order 5820.2A. This Order invokes 10 CFR 61.55 for disposition of waste designated as greater-than-class C, but does explicitly re-state the limits for Class A, B, or C with the exception of the 100 nCi/g limit for TRU elements. Class A, B, and C limits are based on the NRC requirements for LLW land disposal per 10 CFR 61.55. The maximum permissible concentrations of ^{99}Sr, ^{99}Tc, ^{137}Cs, and TRU in the LLW glass based on the Class A, B, and C limits are provided in Table 1.

Table 1. 10 CFR 61.55 Limits in LLW Glass.

	Class A (Ci/m^3)	Class B (Ci/m^3)	Class C (Ci/m^3)
^{137}Cs	1	44	4600
^{90}Sr	0.04	150	7000
^{99}Tc	0.3		3
TRU	10 nCi/g		100 nCi/g

An analysis of radionuclide removal requirements on a tank-by-tank basis (Schultz 1995) shows that no additional removal of soluble ^{90}Sr is required for any tank to meet the NRC Class C or the proposed incidental waste requirements. The analysis also shows that only six DSTs (241-AN-102, 241-AN-107, 241-AY-101, 241-AP-107, 241-AZ-101, and 241-AZ-102) require some removal of soluble TRU to meet the NRC Class C requirement for TRU (100 nCi TRU/g glass). The study indicates that TRU removal for the six DSTs can be attained with additions of HaOH and/or Fe(III) as demonstrated by laboratory testing (Herting 1993, 1994a, 1994b, Washington 1990). Destruction of organic complexants is not required to meet the NRC Class C or incidental waste requirements.

INCIDENTAL WASTE CLASSIFICATION

Incidental waste limits are based on the petition to the NRC (reference 1) to dispose of 2-3 percent of the total radionuclide inventory that originally entered the tanks as incidental waste. This is interpreted to be 7 MCi total radionuclides, including daughters (decay date 1999) for disposal in LLW. This interpretation is detailed below. The basis for this interpretation is provided by the calculations documented in Attachment 2. The results of the calculations are given in Table 2.

Table 2. Incidental Waste Allocation.

	Incidental Waste	
	Allocation (MCi)	Equivalent Average Concentration (Ci/m^3)
^{137}Cs	0.4	2.5
^{137}Ba	0.38	--
^{90}Sr	3.1	19
^{90}Y	3.1	--
^{99}Tc	0.03	0.19
TRU	N/A	<100 nCi/g

The curie content of the cesium and strontium capsules is 132.8 MCi (decay date 1999). These curies are counted as part of the inventory that originally entered the tanks. The current curie content of the SSTs and DSTs is 176 MCi (decay date 1999). The curries allowable to the LLW glass (7.0 MCi) are 4 percent of the existing tank inventory (176 MCi) and 2.2 percent of the total radionuclides that originally entered the tanks (308 MCi). The NRC must still evaluate the treatment and disposal plans for SST waste. However, it is assumed that equivalent criteria will be applied and the curries planned for disposal in LLW already meet the original criteria in the 58 FR 12344 ruling.

Therefore, to be classified as Incidental Waste, the **TOTAL** radionuclide content of the LLW glass produced from all the wastes in both DSTs and SSTs should not exceed 7.0 MCI (decay date 1999). The proposed Incidental Waste limit of 7 MCi to LLW results in an allocation limit in addition to the Class C concentration limit for individual radionuclides. It should be noted that the proposed allocation limit and the associated equivalent concentration are more restrictive than the Class C concentration limits.

IMPACTS OF LIMITS ON SEPARATION SOLIDS CARRYOVER REQUIREMENTS

Based on the current tank inventories and the values for soluble and insoluble fractions for TRU, ^{90}Sr, and ^{137}Cs, an estimate can be made of the maximum solids carryover allowed to the LLW stream for vitrification. Assuming that no soluble TRU is removed from the tank waste, the resulting average TRU concentration in the LLW from soluble TRU would be 25 nCi/g of glass. Calculations show (Attachment 2) that the additional maximum average carryover of entrained solids (after sludge washing) allowed during pretreatment is approximately 25 percent of the insoluble TRU and 3 percent of the total insolubles. Table 3 provides the applicable limits and maximum allowable solids in the LLW.

Table 3. Maximum Allowable Solids in LLW.

LLW Criteria	Limit	Portion of Limit From solids (Maximum)	Maximum Allowable solids Carryover to LLW	Average Turbidity in Separated Liquids
Incidental Waste	7 MCi	3.4 MCi	3 percent total	300
Class C for TRU	100 sq. nCi/g	75 nCi/g	25 percent average	1600

As shown above, the solids carryover allowed is not bounded by TRU elements concentration limits, but by the total radionuclide allocation imposed by the incidental waste criteria. Also, to exceed the TRU element limits given, would require effective total breakthrough of any filtration devices or undetected system failure since the average allowable TRU solids carryover is large.

It is recognized that during abnormal operations or upset conditions affecting the pH during the solids washing step the character of the solids could change. The hot laboratory testing program will define wash step procedures that maintain pH control.

CONCLUSION

The design requirement values for solids removal of less than 65 nCi TRU/g LLW glass, or less than 100 ppm turbidity, are well below the solids carryover defined by LLW classification limits. The less than 100 ppm turbidity is the design value for primary solids removal and is feed to the filter prior to the ion exchange columns. The filter will remove additional solids and is designed to protect the ion exchange column from plugging.

It is recognized that there may be some tendency for TRU to be concentrated in smaller particle sizes. With a design basis of 100 ppm turbidity or 1 percent solids carryover, the average amount of TRU in fine particles that pass the filter must be greater than 25 percent before the LLW limit is violated. To date, we have not seen laboratory data that indicates this is a problem. Any laboratory data developed concerning TRU distribution as a function of particle size and particle size distribution as a function of the liquid/solids processing chemistry and physical handling must be evaluated during design. It is known that certain solids removal operations, (i.e., the cross-flow filter) results in smaller particle size distribution and has more stringent size requirements.

REFERENCES

1. Bernero, R. M, Director Office of Nuclear Materials Safety and Safeguards, U.S. Nuclear Regulatory Commission memorandum dated March 2, 1993 to J. Lytle, Deputy Assistant Secretary for Waste Operations, Office of Waste Management, Environmental Restoration and Waste Management, U.S. Department of Energy, Washington, D. C.

2. Herting, D. L., 1993, *Effect of Tank 107-AN Caustic Addition on Radionuclide Solubilities*, Internal Memo 12110-PCL93-043, Westinghouse Hanford Company, Richland, Washington.

3. Herting, D. L., 1994a, *Strontium Removal Study--Feed Characterization,* Internal Memo 12110-PCL94-017, Westinghouse Hanford Company, Richland, Washington.

4. Herting D. L., 1994b, *Strontium Removal by Precipitation,* Internal Memo 12110-PCL94-026, Westinghouse Hanford Company, Richland, Washington.

5. Rizzo, A. J., Assistant Manager for Operation, U.S. Department of Energy, Richland Operations Office memorandum, dated March 6, 1989, to R. M. Bernero, Director Office of Nuclear Materials Safety and Safeguards, U.S. Nuclear Regulatory Commission.

6. Schulz, W. W., M. M. McKeon, and M. J. Kupfer, *In-Tank Processes for Destruction of Organic Complexants and Removal of Selected Radionuclide*, WHC-SD-WM-ES-321, January 1995 Draft, Westinghouse Hanford Company, Richland, Washington.

7. Washington, L. O., 1990, *Chemical Addition to Tank 107-AN*, Internal Memo 16220-PCL90-079, Westinghouse Hanford Company, Richland, Washington.

ATTACHMENT 2

APPLICATION AND CALCULATION FOR APPLICATION OF THE INCIDENTAL WASTE RULING

The quantity of radionuclides routed to LLW treatment and disposal from processing DST wastes was estimated to be 2 to 3 percent of the total original inventory generated from reprocessing spent nuclear fuel (i.e., HLW that originally entered the tanks).

CURRENT DST/SST INVENTORY

The curie content of the cesium and strontium capsules are 132.8 MCi (decay date 1999). these curies are counted as part of the inventory that originally entered the tanks. The curie content of the SST and DSTs is 176 MCi (decay date 1999). The curies allowable to the LLW glass (7.0 MCi) is 4 percent of the existing tank inventory and 2.2 percent of the total radionuclides that originally entered the tanks.[1] The NRC must still evaluate the treatment and disposal plans for SST wastes. However, it is assumed that equivalent criteria will be applied and the curies planned for disposal in LLW already meet the original criteria in the 58 FR 12344 ruling.

To be classified as Incidental Waste, the **TOTAL** radionuclide content of the LLW glass produced from all the wastes in both DSTs and SSTs should not exceed 7.0 MCi (decay date 1999). This number is 4 percent of the total tank radionuclide inventory (176 MCi) currently estimated to be in the SST and DSTs and 2.2 percent of the total radionuclides that originally entered the tanks.

Since all nuclides currently are within the applicable concentration limits for LLW disposal (i.e., Class C), if ^{137}Cs removal from the water soluble wastes is accomplished very efficiently, the Incidental Waste criterion can be met without any need to remove ^{90}Sr, ^{99}Tc, or TRU elements for DSTs (i.e., the total Ci content criteria will be met). If the efficiency of the radiocesium removal process is reduced, then removal of ^{90}Sr from liquids in the five DSTs containing CC waste may be necessary. These latter five tanks contain higher amounts of ^{90}Sr than do the other DSTs.

Glasses made from supernatant liquids in at least 15 of the 28 DSTs will contain less than 10 nCi/g of TRU elements without pretreatment. The ^{90}Sr concentration in glasses made from supernatant liquid in at least 21 of the DSTs will contain less than 150 Ci ^{90}Sr/m^3 without pretreatment.

---

[1]The curies of ^{137}Cs-Ba and ^{90}Sr-Y used for calculations represent 99.4 percent of all radionuclides.

DESIGN REQUIREMENTS

For the IPM, the requirement for the solids/liquid filter design (i.e., feed clarification of supernatants prior to the ion exchange column), is given below.

Section 3.2.1.3.3 Solids/Liquid Separation (From the IPM DRD). Primary solids/liquid separation is provided by settle/decant operations in the existing DSTs. Secondary filtration of entrained solids from decanted supernatants prior to concentration shall be provided by the IPM project. Solids removal from the retrieved supernatants shall meet the most restrictive of the following two specifications:

(1) Remove entrained TRU solids so that the sum of soluble TRU elements and insoluble TRU elements results in a concentration of less than 540 nCi TRU elements/g Na (less than 65 nCi TRU elements/g glass) (Function 4.2.2.3.2.1).

(2) Entrained solids shall be removed from the retrieved supernatants to a maximum of 100 ppm.

Section 3.2.1.5.1 Cesium Separation. Cesium-137 shall be removed to achieve less than 7.0 MCi (decay date December 31, 1999) total radionuclides for disposal in the LLW glass. The 7.0 MCi includes the total soluble and insoluble ^{137}Cs-Ba, ^{90}Sr-Y, and TRU elements for the DST and SST tank inventory.

The calculation to support the values provided in the requirements is given below:

Solubility assumptions for SSTs: 25 percent total ^{137}Cs is insoluble; 99 percent total ^{90}Sr is insoluble.

Table 1. 1999 Decay Data for Selected Radionuclides. (Data from Shelton 1995)

	Single-Shell Tanks		Double-Shell Tanks	
	Soluble	Insoluble	Soluble	Insoluble
TRU	3.53 E+03 Ci	4.91 E+04 Ci	6.96 E+03 Ci	7.98 E+04 Ci
^{137}Cs-Ba	11.8 E+06 Ci	3.92 E+06 Ci	51.1 E+06 Ci	1.20 E+06 Ci
^{90}Sr-Y	0.83 E+06 Ci	82.2 E+06 Ci	2.4 E+06 Ci	21.8 E+06 Ci

Table 2. Totals (1999 Decay Data).

	Tank Waste			
	Soluble	Insoluble	Capsules	Total
TRU	1.05 E+04 Ci	1.29 E+05 Ci		1.4 E+05 Ci
^{137}Cs-Ba	62.9 E+06 Ci	5.12 E+06 Ci		
^{90}Sr-Y	2.93 E+06 Ci	104 E+06 Ci		
TOTAL	65.8 MCi	110.4 MCi	132.8 MCi	309 MCi

General equation: Solve for allowable solids carryover. Total Radionuclide Inventory is 176 MCi. Applying incidental waste criterion of 4 percent of the current tank inventory (2.2 percent of the 309 MCi originally entering the tank) gives 7.0 MCi for disposal in LLW glass.

$$(\text{TRU} + {}^{90}\text{Sr-Y} + {}^{137}\text{Cs-Ba})_{\text{Soluble}} + (\text{TRU} + {}^{90}\text{Sr-Y} + {}^{137}\text{Cs-Ba})_{\text{Insoluble}} \leq 7.0 \text{ MCi}$$

Assume soluble Cs ion exchange DF = 100

$$[(\text{TRU})+({}^{90}\text{Sr-Y})+(0.01)({}^{137}\text{Cs-Ba})]_{\text{Soluble}} + (\text{TRU} + {}^{90}\text{Sr-Y} + {}^{137}\text{Cs-Ba})_{\text{Insoluble}} \leq 7.0 \text{ MCi}$$

$$0.01 \text{ MCi} + 3 \text{ MCi} + (0.01)(62.9 \text{ MCi}) + (\text{TRU} + {}^{90}\text{Sr-Y} + {}^{137}\text{Cs-Ba})_{\text{Insoluble}} \leq 7.0 \text{ MCi}$$

$$0.01 + 3 + 0.63 + (\text{TRU} + {}^{90}\text{Sr-Y} + {}^{137}\text{Cs-Ba})_{\text{Insoluble}} \leq 7.0 \text{ MCi}$$

$$(\text{TRU} + {}^{90}\text{Sr-Y} + {}^{137}\text{Cs-Ba})_{\text{Insoluble}} \leq 3.4 \text{ MCi insolubles (decayed date 1999)}$$

3.4 MCi of insolubles (includes TRU, Sr, and Cs) represents 1.9 percent of the total curies and 3 percent of total insolubles. The total amount of tank supernatants, dissolved salts, and wash solutions is 1.11+E06 MT. The total amount of insolubles is 1.20+E04 kg. A 3 percent carryover of solids into the aqueous phase results in an average turbidity of 300 ppm.

CALCULATION FOR CURIES OF ^{137}Cs IN THE LLW GLASS:

The amount of ^{137}Cs in the glass is the sum of the insoluble cesium curies plus the soluble cesium curies (i.e., ion exchange raffinate).

Curie contribution from insoluble ^{137}Cs-Ba is:

(5.123 MCi÷110.4 total MCi) * 3.4 MCi = 0.16 MCi ^{137}Cs-Ba (decay date 1999)

Curie contribution from soluble ^{137}Cs-Ba is (0.01 * 62.9 MCi) = 0.63 MCi ^{137}Cs-Ba (decay date 1999)

Total = 0.16 MCi + 0.63 MCi = 0.79 MCi of ^{137}Cs-Ba.

This represents about 0.4 MCi ^{137}Cs (decay date 1999).

For 423,000 MT LLW glass at a 2.66 glass density (MT/m^3):

(0.4 MCi) ÷ [423,000 MT glass ÷ 2.66 $_{\text{(glass density)}}$] = 2.5 Ci/m^3 Cs only, in the LLW glass.

Calculation for curies of ^{90}Sr in the LLW glass:

The amount of ^{90}Sr in the glass is the sum of the insoluble strontium curies plus the soluble strontium curies. Curie contribution from insoluble ^{90}Sr-Y is:

(104 MCi ÷ 110.4 total MCi) * 3.4 MCi = 3.2 MCi ^{90}Sr-Y (decay date 1999)

curie contribution from soluble ^{90}Sr-Y is: 2.93 MCi ^{90}Sr-Y (decay date 1999)

Total = 3.2 2.93 = 6.13 MCi of ^{90}Sr-Y

This represents 3.1 MCi of ^{90}Sr

For 423,000 MT LLW glass at a 2.66 glass density (MT/m^3):

(3.1 MCi) ÷ [423,000 MT glass ÷ 2.66 $_{\text{(glass density)}}$] = 19 Ci/m^3 Sr, only in the LLW glass

CLASS C EVALUATION FOR TRU:

Soluble TRU: 1.05 E+13 nCi ÷ 423 E+09 g glass = 26 nCi/g

Insoluble TRU: 1.29 E+14 nCi ÷ 423 E+09 g glass = 305 nCi/g (average)

For a limit of 100 nCi/G soluble and insoluble TRU, amount of insoluble TRU loss to LLW glass:

Soluble nCi/G + allowable insoluble nCi/g = 100 nCi/g

25 nCi/g + allowable insoluble nCi/g = 100 nCi/g

Insoluble nCi/g = 75 nCi/g

percent allowable insoluble TRU (75 nCi/g ÷ 305 nCi/g) * 100 percent

percent allowable insoluble TRU = 25 percent

GLOSSARY

ABBREVIATIONS, ACRONYMS

AE/CM	Architect-Engineer/Construction Manager
ALARA	As low as reasonably achievable
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
BACT	Best available control technology
BARCT	Best available radionuclide control technology
BCCB	Bulk cold chemical building
CC	Complexant concentrate
D&D	Decontamination and decommissioning
DBA	Design basis accident
DCG	Derived concentration guide
DCS	Distributed control system
DF	Decontamination factor
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy-Richland Operations Office
DOH	Washington State Department of Health
DP	Differential pressure
DRD	Design Requirements Document
DSSF	Double-shell slurry feed
DST	Double-shell tank
EDE	Effective Dose Equivalent
EHSC	Environmental hazard safety classification
EPA	U.S. Environmental Protection Agency
ETF	Effluent Treatment Facility
FDC	Functional Design Criteria
FEMP	Facility Effluent Monitoring Plan
HEPA	High-efficiency particulate air
HLW	High-level waste
HPS	Hanford Plant Standards; health protection system
HVAC	Heating, ventilating, and air-conditioning
LERF	Liquid Effluent Retention Facility
LETF	Liquid Effluent Treatment Facility
LLW	Low-level waste
LLWVP	Low-Level Waste Vitrification Plant
NCAW	Neutralized current acid waste

ABBREVIATIONS, ACRONYMS (CONTINUED)

NEPA	*National Environmental Policy Act*
NFPA	National Fire Protection Association
NRC	Nuclear Regulatory Commission
OSHA	Office of Safety and Health Administration
PCB	Polychlorinated Biphenyl
PHP	Pneumatic hydropulse
RAEP	Radionuclide Air Emission Program
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	U.S. Department of Energy, Richland Operations Office
RLIP	U.S. Department of Energy, Richland Operations Office Implementing Procedure
SDC	Standard Arch-Civil Design Criteria
SEWP	Systems Engineering Working Plan
SpG	Specific Gravity
SST	Single-shell tank
T-BACT	Best available control technology for air toxics
TBD	To be determined
TEDF	Treated Effluent Disposal Facility
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRS	Technical Requirements Specification
TRU	Transuranic
TSD	Treatment, storage, and disposal
TWRS	Tank Waste Remediation System
UST	Underground storage tank
VOG	Vessel offgas
WAC	Washington State Administrative Code
WHC	Westinghouse Hanford Company
WISHA	Washington Industrial Safety and Health Act

REFERENCES

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations,* as amended.

10 CFR 830, "Nuclear Safety Management, Subpart A, General Provisions, Section 830.120, Quality Assurance Requirements," *Code of Federal Regulations*, as amended.

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

40 CFR 260, "Hazardous Waste Management System: General," *Code of Federal Regulations*, as amended.

40 CFR 262, "Standards Applicable to Generators of Hazardous Waste," *Code of Federal Regulations,* as amended.

40 CFR 263, "Standards Applicable to Transporters of Hazardous Waste," *Code of Federal Regulations,* as amended.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations,* as amended.

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations,* as amended.

40 CFR 280, "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks," *Code of Federal Regulations,* as amended.

42 USC 6901, "Resource Conservation and Recovery Act of 1976 and Hazardous and Solid Waste Amendments of 1984."

Alumkal, W. T., 1994a, *Configuration Selection for the Tank Waste Remediation System*, to T. R. Sheridan, #9454691, July 18, 1994, Westinghouse Hanford Company, Richland, Washington.

Alumkal, W. T., 1994b, *Hanford Site Tank Waste Remediation Technical Strategy*, Letter #8 to J. L. Straalsund, Westinghouse Hanford Company, Richland, Washington.

ANSI/ISA, 1985, *Graphic Symbols for Process Displays*, ANSI/ISA-S5.5-1985, American National Standards Institute/Instrument Society of America, New York, New York.

ANSI/ISA, 1991, *Instrument Loop Diagrams*, ANSI/ISA-S5.4-1991, American National Standards Institute/Instrument Society of America, New York, New York.

ANSI/ISA, 1992 (R), *Binary Logic Diagrams for Process Operations*, ANSI/ISA-S5.2-1976, American National Standards Institute/Instrument Society of America, New York, New York.

ANSI/ISA, 1994, *Instrumentation Symbols and Identification*, ANSI/ISA-S5.1-1994, American National Standards Institute/Instrument Society of America, New York, New York.

ASME, 1989, *Quality Assurance Program Requirements for Nuclear Facilities*, ASME NQA-1-1989, American Society of Mechanical Engineers, New York, New York.

Bernero, R. M., 1993, United States Nuclear Regulatory Commission, letter to Ms. Jill Lytle, Deputy Assistant Secretary for Waste Operations Office of Waste Management, Environmental Restoration, and Waste Management.

Boomer, K. D., S. K. Baker, A. L. Boldt, J. D. Galbraith, J. S. Garfield, C. E. Golberg, B. A. Higley, L. J. Johnson, M. J. Kupfer, R. M. Marusich, R. J. Parazin, A. N. Praga, G. W. Reddick, J. A. Reddick, E. J. Slaathaug, L. M. Swanson, T. L. Waldo, and C. E. Worcester, 1993, *Tank Waste Technical Options Report*, WHC-EP-0616, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Boomer, K. D., J. M. Colby, T. W. Crawford, J. S. Garfield, J. D. Galbraith, C. E. Golberg, C. E. Leach, D. E. Mitchell, F. D. Nankani, E. J. Slaathaug, L. M. Swanson, T. L. Waldo, C. M. Winkler, 1994, *Tank Waste Remediation System Facility Configuration Study*, WHC-SD-WM-ES-295, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Bray, L. A., C. D. Carlson, K. J. Carson, J. R. DesChane, R. J. Elovich, and D. E. Kurath, 1993, *Initial Evaluation of Two Organic Resins and Their Ion Exchange Column Performance for the Recovery of Cesium from Hanford Alkaline Wastes*, TWRSPP-93-055, prepared by Pacific Northwest Laboratory for Westinghouse Hanford Company, Richland, Washington.

Brooks, K. P., 1994, *Cesium Ion Exchange Using Actual Waste: Column Size Considerations*, TWRSPP-94-091, Pacific Northwest Laboratory, Richland, Washington.

Colby, J. M., 1994, *Preliminary Offsite Dose Calculations for Tank Waste Remediation System Activities*, internal memo to J. S. Garfield, Westinghouse Hanford Company, Richland, Washington.

DeLorenzo, D. S., 1994, *Tank Characterization Report for Double-Shell Tank 241-AP-102*, WHC-SD-WM-ER-358, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DeLorenzo, D. S., 1994, *Tank Characterization Report for Double-Shell Tank 241-AP-105*, WHC-SD-WM-ER-360, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

DOE, 1988a, "Final Environmental Impact Statement for the Disposal of Hanford Defense High-Level, Transuranic and Tank Waste, Hanford Site, Richland, Washington, Record of Decision," *Federal Register* V 53(7.2)pp 12449-12453, U.S. Department of Energy, Washington, D.C.

DOE, 1988b, *Radiation Protection for Occupational Workers*, DOE Order 5480.11, U.S. Department of Energy, Washington, D.C.

DOE, 1989, *General Design Criteria*, DOE Order 6430.1A, U.S. Department of Energy, Washington, D.C.

DOE, 1990a, *Hanford Plant Standards*, DOE RL Order 6430.1C, U.S. Department of Energy, Washington, D.C.

DOE, 1990b, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, U.S. Department of Energy, Washington, D.C.

DOE, 1991, *Liquid Effluent Retention Facility Dangerous Waste Permit Application*, DOE/RL 90-43, Rev. 0, 1 Part B, U.S. Department of Energy, Richland, Washington.

DOE, 1991, *Tank Waste Remediation System Technical Requirements Specification*, Draft, U.S. Department of Energy, Richland, Washington.

DOE, 1992, *Radiological Control*, DOE Order N 5480.6, U.S. Department of Energy, Washington, D.C.

DOE, 1993, *Radioactive Waste Management*, DOE Order 5820.2A, U.S. Department of Energy, Washington, D.C.

DOE, 1994a, *Fiscal Year 1995 Hanford Mission Plan*, DOE/RL-93-102, UC-630, Draft February 15, 1994, published March 1994, U.S. Department of Energy, Richland, Washington.

DOE, 1994b, *Tank Waste Remediation System Functions and Requirements*, DOE/RL-92-60, Rev. 1, March 1994, U.S. Department of Energy, Richland, Washington.

DOE, 1994c, *Tank Waste Remediation Systems (TWRS) Systems Engineering Management Plan*, DOE/RL-93-0106 (Annex 2), U.S. Department of Energy, Richland, Washington.

Ecology, EPA, DOE, 1994, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Howden, G. F., 1994, *TWRS Tank Waste Pretreatment and Treatment Process Development Testing Requirements Assessment*, WHC-SD-WM-TA-156, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Johnson, M. E., 1994, *Tank Waste Remediation System Decisions and Risk Assessment*, WHC-EP-0786, Westinghouse Hanford Company, Richland, Washington.

Kurath, D. E., L. A. Bray, K. P. Brooks, C. D. Carlson, and A. Y. Kim, 1993, *Analysis of Equilibrium Date For Cesium Ion Exchange of Hanford CC and NCAW Supernatant Liquid--Status Report*, TWRSPP-93-051, Prepared by Pacific Northwest Laboratory for Westinghouse Hanford Company, Richland, Washington.

Kurath, D. E., L. A. Bray, K. P. Brooks, G. N. Brown, S. A. Bryan, C. D. Carlson, K. J. Carson, J. R. DesChange, R. J. Elovich, and A. Y. Kim, 1994, *Experimental Data and Analysis to Support the Design of an Ion Exchange Process for the Treatment of Hanford Tank Waste Supernatant Liquids,* TWRSPP-94-010, Pacific Northwest Laboratory, Richland, Washington.

McDonald, F. N., 1994, *Acceptance of Feed Streams for Storage and Treatment at the LERF/ETF Complex*, WHC-SD-ETF-WAC-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Neilsen, E. H., 1992, *Miscellaneous Underground Radioactive Waste Tanks*, WHC-EP-0560, Westinghouse Hanford Company, Richland, Washington.

Norton, M. V. and F. Torres-Ayala, 1993, *Summary Letter, Laboratory Testing In-Tank Sludge Washing*, TWRSTP-93-060, Pacific Northwest Laboratory, Richland, Washington.

Norton, M. V. and K. A. Zaniboni, 1994, *Draft Summary Letter, Laboratory Testing In-Tank Sludge Washing/Settling Mixer Pump Simulations With NCAW Simulant, Subtask 4.1*, Pacific Northwest Laboratory, Richland, Washington.

Orme, R. M., 1994, *TWRS Process Flowsheet*, WHC-SD-WM-TI-613, Westinghouse Hanford Company, Richland, Washington.

Reddick, G. W., 1994, *Testing and Development Strategy for the Tank Waste Remediation System*, WHC-SD-WM-SP-006, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Reynolds, B., 1994, *Hanford TWRS Waste Pretreatment Program Test Requirements Strategy and Issues,* TWRSTP-94-096, Draft, Pacific Northwest Laboratory, Richland, Washington.

RL, 1991, *Project Management System,* RLIP 4700.1A, U.S. Department of Energy, Richland Field Office, Richland, Washington.

RL, 1994, *Fire Protection*, RLID 5480.7, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Rymarz, P. B., and D. R. Speer, 1991, *Summary of Radioactive Underground Tanks Managed by Hanford Restoration Operations*, WHC-SD-DD-TI-057, Westinghouse Hanford Company, Richland, Washington.

Silva, L. J., and J. B. Duncan, 1992, *Evaluation of In-Tank Processing Approaches for Removal of Cs-137 from Double-Shell Tank Wastes,* prepared by Pacific Northwest Laboratory for Westinghouse Hanford Company, Richland, Washington.

Stickney, R. G., 1988, *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*, WHC-EP-0063, Westinghouse Hanford Company, Richland, Washington.

WAC 173-200, "Water Quality Standards for Groundwaters of the State of Washington," *Washington Administrative Code,* as amended.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code,* as amended.

WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," *Washington Administrative Code*, as amended.

WAC 246-247, "Radiation Protection - Air Emissions," *Washington Administrative Code*, as amended.

WHC, 1994a, *Data Standards Administration*, WHC-CM-2-6, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994b, *Environmental Compliance*, WHC-CM-7-5, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994c, *Radiological Design Guide*, WHC-SD-GN-DGS-30011, Westinghouse Hanford Company, Richland, Washington.

WHC, 1995, *TWRS Site Evaluation Report*, WHC-SD-SD-WM-SE-021, Draft, Westinghouse Hanford Company, Richland, Washington.

Willis, N. P., 1993, *Hanford Site Solid Waste Acceptance Criteria*, WHC-EP-0063-4, Westinghouse Hanford Company, Richland, Washington.

WIPP/DOE, 1991, *Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, WIPP/DOE-069, Rev. 4, U.S. Department of Energy, Washington, D.C.

Wodrich, D. D., 1993, *Miscellaneous Underground Tanks Containing Radioactive Waste*, letter to H. D. Harmon, January 25, 1993, Westinghouse Hanford Company, Richland, Washington.