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RPP-18812, Rev. 1

Tank S-109 Partial Waste Retrieval Functions and Requirements

D. H. Shuford
CH2M HILL Hanford Group, Inc.
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-99RL14047

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Abstract: This document establishes the S-109 Tanks Waste Retrieval system systems specifications (including leak detection, monitoring, and mitigation system specifications), required by milestone M-45-00 of the Hanford Federal Facility Agreement and Consent Order.

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Change Control Record

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr.	Date
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1 RS	1. Section 1.0, Introduction:			
	a. deleted the words "high-level" from the			
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	b. added a new second and third paragraph to			
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	and D. Noyes. This revision changes the			
	pagination and adds new references.			
	2. Table 4:			
	a. deleted the row addressing 10 CFR 61			
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	3. Table 4 (last row)			
	a. changed "basis" from HFFACO to Interim			
	Stabilization Consent Decree.			
	Complete revision, per ECN-721367-R0			

ENGINEERING CHANGE NOTICE

Page 1 of 5 ☒ DM ☐ FM ☐ TM

1a. ECN 721367 R 0

1b. Proj. ECN W- - R

2. Request Information Record Information on the ECN-1 Form	3a. Design Inputs -Record Information on the ECN-2 Form	3b. Design Outputs / References - Record Information on the ECN-3 Form	3c. Engineering Evaluation / Estimate / Approval to Proceed w/ the Design - Record Information on the ECN-4 Form

4. Originator's Name, Organization, MSIN, & Phone No.	5. USQ Number	6. Date
D. H. Shuford, Projects, H6-19, 373-1197	No. TF - - R - ☒ N/A ☐ Refer to Work Package	1-12-04

7. Title	8. Bldg. / Facility No.	9. Equipment / Component ID	10. Approval Designator
Tank S-109 Partial Waste Retrieval Functions and Requirements	S-109/241-S	S-109 Series Tank	EQ

11. Documents/Drawings Changed by this ECN (Record the information on the ECN-5 Form, including sheet and revision numbers.)	12. Design Basis Documents?	13. Safety Designation	14. Expedited / Off-Shift ECN?
	☒ Yes ☐ No	☐ SC ☐ SS ☐ GS ☒ N/A	☐ Yes ☒ No

15a. Work Package Number	15b. Modification Work Completed	15c. Restored to Original Status (TM)	16. Fabrication Support ECN?
N/A	N/A Responsible Engineer / Date	N/A Responsible Engineer / Date	☐ Yes ☒ No

17. **Description of the Change** (Use ECN Continuation pages, as needed)

Revision per the following ORP Comments:

1. Section 1.0, Introduction:
   a. deleted the words "high-level" from the first sentence of the first paragraph.
   b. added a new second and third paragraph to address an agreement between R. Raymond and D. Noyes. This revision changes the pagination and adds new references.

2. Table 4:
   a. deleted the row addressing 10 CFR 61 (Pretreatment)

3. Table 4 (last row):
   a. changed "basis" from HFFACO to Interim Stabilization Consent Decree.

18. **Justification of the Change** (Use ECN Continuation pages, as needed)

Revision required based on comments received from DOE/ORP.

19. **ECN Category**

☒ Direct Revision
☐ Supplemental
☐ Void/Cancel

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☐ Closure
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20. **Distribution**

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~~G.P. Janicek~~ gda 1/13	~~S7-12~~	~~R.E. Butler~~	~~S7-83~~
~~D.H. Shuford~~	~~H6-19~~	~~D.W. Hamilton~~	~~H6-03~~
~~W.T. Thompson~~	~~S7-90~~	~~P.F. Kison~~	~~S7-24~~
~~D.D. Carson~~	~~H6-19~~	~~R.L. Brown~~	~~S7-75~~
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Page 2 of 5 ☒ DM ☐ FM ☐ TM	1b. Proj. ECN W- - R

21. Engineering Check	22. Design Verification Required?	23. Closeout / Cancel / Void
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24. Revisions Planned (Include a brief description of the contents of each revision)

Revision based on comments received from DOE/ORP.

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25a. Commercial Grade Item Dedication Numbers (associated with this design change)	25b. Engineering Data Transmittal Numbers (associated with this design change, e.g., new drawings, new documents)
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26a. Design Cost Estimate	26b. Materials / Procurement Costs	26c. Estimated Labor Hours
N/A	N/A	N/A

27. Field Change Notice(s) Used?	
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28. Approvals

Facility/Project Signatures		Date	A/E Signatures		Date
Design Authority	G.P. Janicek	1/13/04	Originator/Design Agent		
Team Lead/Lead Engr.	D.H. Shuford	1/12/04	Professional Engineer		
Resp. Engineer	P.F. Kison	01/13/04	Project Engineer		
Resp. Manager	D.W. Hamilton	1/12/04	Quality Assurance		
Quality Assurance	D.D. Carson	1/12/04	Safety		
IS&H Engineer			Designer		
NS&L Engineer			Environ. Engineer		
Environ. Engineer	F.R. Miera	1/12/04	Other		
Project Engineer			Other		
Design Checker			DEPARTMENT OF ENERGY / OFFICE OF RIVER PROTECTION		
Design Verifier			Signature or a Control Number that tracks the Approval Signature		
Operations					
Radcon			ADDITIONAL SIGNATURES		
EQRG					
Other / PTH					

ECN - 1 ENGINEERING REQUEST FORM	1a. ECN 721367 R 0
Page 3 of 5 ☒ DM ☐ FM ☐ TM	1b. Proj. ECN W- - R

Requestor's Name (Print)	*Date*	REA Reference
D.H. Shuford	1-12-04	N/A
Equipment Name		Estimated Need Date
S-109 Tank		1-19-04

Problem/Issue Statement

Purpose for the Proposed Modification

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Basis for the Estimated Need Date

The document revision is required to incorporate comments from DOE/ORP review.

Requestor's Signature	*Date*
D.H. Shuford David H Shuford	1/12/04

Responsible Engineering Manager Approval

Work Package Number (If Known)	Estimated Evaluation ROM Cost	*CACN*
N/A	$1000	
Process as a Simple Modification? ☒ Yes ☐ No	***Assigned to (Team Lead)*** D.H. Shuford	***Date*** 1-12-04
Responsible Engineering Manager (Print) WT Thompson	☒ Approve ☐ Reject	***Date*** 1-12-04

If rejected, explain reason for rejection:

N/A

(Once rejected the Responsible Engineering Manager returns the request to the Requestor)

Italicized text items need to be addressed. Standard text items need to be addressed as applicable to the problem/issue described.

ECN - 5 DRAWING / DOCUMENT CHANGE LIST FORM	1a. ECN 721367 R 0
Sheet 1 of ECN – 5 Page 4 of 5 ☒ DM ☐ FM ☐ TM	1b. Proj. ECN W- - R

List of Engineering Drawings/Documents Changed (Use the attached checklist for guidance)

Dwg./Doc. Number (Sheet/Page, Rev)	Title/Type	Shared	PC-002/ SDD/ HNF-3240/ HNF-4184	Existing Change Document Nos.
RPP-18812, Rev. 0	Tank S-109 Partial Waste Retrieval Functions and Requirements	☐	☐	
		☐	☐	
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		☐	☐	

Submitted to Document Service Center Prior to ECN Release?

☐ Yes ☒ No

List of Non-Engineering Documents Needing Change

Document Number/Revision, Sheet/Page (If Available)	Document Title	Document Owner (Organization)	Individual Notified	Method	Date Notified
N/A					

ECN - 5
DRAWING / DOCUMENT CHANGE LIST FORM

Sheet 2 of ECN – 5
Page 5 of 5

☒ DM ☐ FM ☐ TM

1a. ECN 721367 R 0

1b. Proj. ECN W- - R

Drawings/Documents to be Modified Checklist

System Design Description	☐ Yes ☒ No ☐ N/A	Security Plan	☐ Yes ☒ No ☐ N/A
Functional Design Criteria	☐ Yes ☒ No ☐ N/A	Emergency Plan	☐ Yes ☒ No ☐ N/A
Functional Requirements	☒ Yes ☐ No ☐ N/A	Calculations (General)	☐ Yes ☒ No ☐ N/A
Specification (Equipment or Operating)	☐ Yes ☒ No ☐ N/A	Operating Procedure	☐ Yes ☒ No ☐ N/A
Criticality Specification	☐ Yes ☒ No ☐ N/A	System / Subsystem Specifications	☐ Yes ☒ No ☐ N/A
Design Report	☐ Yes ☒ No ☐ N/A	Material Specification / BOM	☐ Yes ☒ No ☐ N/A
Training Plan	☐ Yes ☒ No ☐ N/A	Sampling Plan	☐ Yes ☒ No ☐ N/A
Equipment Specification	☐ Yes ☒ No ☐ N/A	Inspection Plan	☐ Yes ☒ No ☐ N/A
Procurement Specification	☐ Yes ☒ No ☐ N/A	Spare Parts List	☐ Yes ☒ No ☐ N/A
Construction Specification	☐ Yes ☒ No ☐ N/A	Test Specification	☐ Yes ☒ No ☐ N/A
Vendor Information	☐ Yes ☒ No ☐ N/A	Acceptance Test Plan	☐ Yes ☒ No ☐ N/A
Design Drawings	☐ Yes ☒ No ☐ N/A	Acceptance Test Procedure	☐ Yes ☒ No ☐ N/A
Safety Analysis / FSAR / SAR / DSA	☐ Yes ☒ No ☐ N/A	Pre-Operational Test Procedure	☐ Yes ☒ No ☐ N/A
Technical Safety Requirement	☐ Yes ☒ No ☐ N/A	Operation Test Plan	☐ Yes ☒ No ☐ N/A
Master Equipment List	☐ Yes ☒ No ☐ N/A	Operational Test Procedure	☐ Yes ☒ No ☐ N/A
Safety Equipment List	☐ Yes ☒ No ☐ N/A	ASME Coded Item / Vessel	☐ Yes ☒ No ☐ N/A
Functional Analysis	☐ Yes ☒ No ☐ N/A	Automated Control Configuration Plan	☐ Yes ☒ No ☐ N/A
Environmental Requirement / Review	☐ Yes ☒ No ☐ N/A	Computer / Automated Control Software Plan	☐ Yes ☒ No ☐ N/A
Scope Description Document	☐ Yes ☒ No ☐ N/A	Process Control Plan	☐ Yes ☒ No ☐ N/A
Seismic / Stress / Structural Analysis	☐ Yes ☒ No ☐ N/A	Process Control Procedure	☐ Yes ☒ No ☐ N/A
Engineering Study	☐ Yes ☒ No ☐ N/A	Purchase Requisition	☐ Yes ☒ No ☐ N/A
Interface Control Drawing / Document	☐ Yes ☒ No ☐ N/A	Hazards Review	☐ Yes ☒ No ☐ N/A
Maintenance Procedure(s)	☐ Yes ☒ No ☐ N/A	JCS PM Activity Datasheet	☐ Yes ☒ No ☐ N/A
Setpoint / Tolerance Document	☐ Yes ☒ No ☐ N/A		☐ Yes ☐ No ☐ N/A
	☐ Yes ☐ No ☐ N/A		☐ Yes ☐ No ☐ N/A
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DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	D.H. Shuford	Date 1-12-04
Project Title/Work Order		EDT No.
Tank S-109 Partial Waste Retrieval Functions and Requirements		ECN No. ECN-721367-R0

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
D.W. Hamilton	H6-03	x			
M.H. Sturges	S7-12	x			
D.H. Shuford	H6-19	x			
M.W. Leonard	H6-19	x			
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A-6000-135 (10/97)

TANK S-109 PARTIAL WASTE RETRIEVAL FUNCTIONS AND REQUIREMENTS

January 12, 2004

Prepared By
CH2M HILL Hanford Group, Inc.
Richland, Washington

EXECUTIVE SUMMARY

This document establishes the functions and requirements for the partial retrieval of waste stored in tank S-109 in support of a planned treatment demonstration. This tank is designated as sound and is located in the 200 West Area of the Hanford Site. The retrieval of waste from tank S-109 will integrate leak detection, monitoring, and mitigation with technologies to minimize the potential for leaks to occur during waste retrieval and the resulting leak volume should a leak occur.

The retrieval of waste from tank S-109 will occur in three separate phases:

- **Phase 1 – Salt Cake Dissolution:** 300 gallons of tank waste (dissolved in approximately 1,000 gallons of brine) will be retrieved from the tank for transfer to the Test and Demonstration Facility. Saltwell-type equipment will be used to retrieve waste. Additional equipment such as a low volume sluicer nozzle may be used in combination with the saltwell-type equipment.
- **Phase 2– Controlled Sluicing:** 200,000 to 300,000 gallons of tank waste will be retrieved using a pump and low volume sluice nozzles. The existing saltwell pump might be used or a new pump installed following system definition.
- **Phase 3:** The balance of the waste will be retrieved in accordance with the *Hanford Federal Facility Agreement and Consent Order*.

Waste retrieval from tank S-109 during Phase 1 and Phase 2 that does not meet the waste feed requirements of the treatment demonstration facility will be sent to a double-shell tank. It is estimated that as much as 30,000 gallons of waste could be sent to a double-shell tank during Phase 1. Up to 100,000 gallons of waste total could be sent to a double-shell tank during Phase 1 and Phase 2 combined.

Only Phases 1 and 2 are addressed in this document. This document will be revised or a new document prepared in the future to address retrieval of the balance of the waste in the tank during Phase 3.

This document establishes the functions and requirements for both the tank S-109 partial waste retrieval system and the leak detection, monitoring, and mitigation system. The specifications are based on the waste retrieval technologies best suited to the specific tank conditions and leak detection and monitoring technologies that are consistent with the waste retrieval technologies. The functions and requirements also consider human health risks associated with the tank waste and potential waste volumes that could leak during retrieval.

The waste retrieval systems planned for deployment during Phase 1and Phase 2 will control the volumes of water added and the location to limit the potential for leakage to occur and to limit the resulting volumes if a leak were to occur. Therefore, the risk-based leak detection and monitoring strategy is based on preventing leakage, minimizing leak volumes if a leak should occur, and using best available leak detection and monitoring technologies to detect leaks from tank S-109. During Phase 1 waste retrieval drywell monitoring will be used as the primary leak detection method. During Phase 2 high-resolution resistivity will be deployed as the primary leak detection and monitoring method.

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LIST OF TERMS

DOE	U.S. Department of Energy
DST	double-shell tank
F&R	functions and requirements
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
HRR	high-resolution resistivity
ILCR	incremental lifetime cancer risk
LDM	leak detection and monitoring
LDMM	leak detection, monitoring, and mitigation
LOW	liquid observation well
ORP	Office of River Protection
REDOX	reduction-oxidation extraction (plant)
SST	single-shell tank
TDF	Test and Demonstration Facility
WRS	waste retrieval system

1.0 INTRODUCTION

The River Protection Project mission includes storage, retrieval, immobilization, and disposal of mixed radioactive waste presently stored in 177 underground tanks located in the 200 East and 200 West Areas of the U.S. Department of Energy (DOE) Hanford Site. The River Protection Project is in the process of accelerating single-shell tank (SST) waste retrievals, and developing supplemental technologies to augment the Waste Treatment Plant for treating the retrieved waste. Tank S-109, located in the 200 West Area (Figure 1), is a tank that has been selected for partial waste retrieval. This tank was selected for partial retrieval because a portion of the waste in the tank meets the waste feed requirements of the waste treatment technology demonstration.

The treatment of the Hanford tank waste is required under the *Hanford Federal Facility Agreement and Consent Order* (HFFACO; Ecology et al. 1989) signed by the Washington State Department of Ecology (Ecology), the U.S. Environmental Protection Agency, and DOE.

In a letter to the Richland DOE Operations Office (Paperiello 1997) the Nuclear Regulatory Commission documented an agreement with DOE to classify a portion of the Hanford tank waste as "incidental waste" in accordance with the incidental waste classification criteria specified in an earlier letter from the Nuclear Regulatory Commission to DOE (Bernero 1993). The lower activity portion of the tank waste, referred to as low-activity waste, refers to the saltcake portion of the S-109 tank waste. Following radionuclide removal and vitrification, the immobilized low-activity waste will be considered incidental waste.

Full retrieval of waste from tank S-109 will occur in three separate phases:

- **Phase 1– Salt Cake Dissolution:** 300 gallons of tank waste (dissolved in approximately 1,000 gallons of brine) will be retrieved from the tank for transfer to the Test and Demonstration Facility (TDF). Saltwell-type equipment will be used to retrieve waste. Additional equipment such as a low-volume sluicer nozzle may be used in combination with existing saltwell-type equipment.

- **Phase 2– Controlled Sluicing:** 200,000 to 300,000 gallons of tank waste will be retrieved using a pump and low volume sluice nozzles. The existing saltwell pump might be used or a new pump installed following system definition.

- **Phase 3 –** The balance of the waste in tank S-109 will be retrieved in accordance with the HFFACO.

Only Phases 1 and 2 are addressed in this document. This document will be revised or a new document prepared in the future to address retrieval of the balance of the waste in the tank during Phase 3.

Waste retrieved from tank S-109 during Phase 1 and Phase 2 that does not meet the waste feed requirements of the treatment demonstration facility will be sent to a double-shell tank (DST). It is estimated that as much as 30,000 gallons of waste could be sent to a DST during Phase 1. Up to 100,000 gallons could be sent to a DST during Phase 1 and Phase 2 combined.

Tank S-109 currently meets the interim stabilization criteria; however, during partial waste retrieval liquid volumes within the tank may exceed the interim stabilization criteria. After Phase 2 the tank conditions will be consistent with the interim stabilization criteria.

The tank S-109 partial waste retrieval system (WRS) will interface with the TDF as defined in *System Specification for Bulk Vitrification* (RPP-17403). Additional information on the supplemental treatment demonstration and relationship to the tank S-109 WRS is provided in *Research, Development, and Demonstration Permit Application for Bulk Vitrification Test Demonstration Facility* (DOE/RL-2003-23).

The approach used to develop this document includes an integrated waste retrieval and leak detection, monitoring, and mitigation (LDMM) strategy that considers human health risk in the planning and development of WRS requirements.

The major elements of the document consist of the following:

- Long-term human health risk from potential releases (Section 2.0)
- Upper-level functions and requirements (F&R) for the WRS (Section 3.0)
- Description of the WRS and operating strategy (Sections 4.2.1 and 4.3.3)
- Description of the planned approach for LDMM (Section 4.0).

1.1 PURPOSE

This document provides the F&R necessary to institute proper regulatory control of the design activities associated with the WRS for tank S-109 partial waste retrieval. This document also provides a preliminary waste retrieval and LDMM strategy compatible with the F&R.
The strategy combines best available leak detection and monitoring (LDM) methods with an operational strategy designed to reduce the potential for leaks to occur during waste retrieval and the resulting volume in the event a leak should occur. This document additionally provides risk information to establish a basis for making informed decisions in the event a leak is detected during waste retrieval.

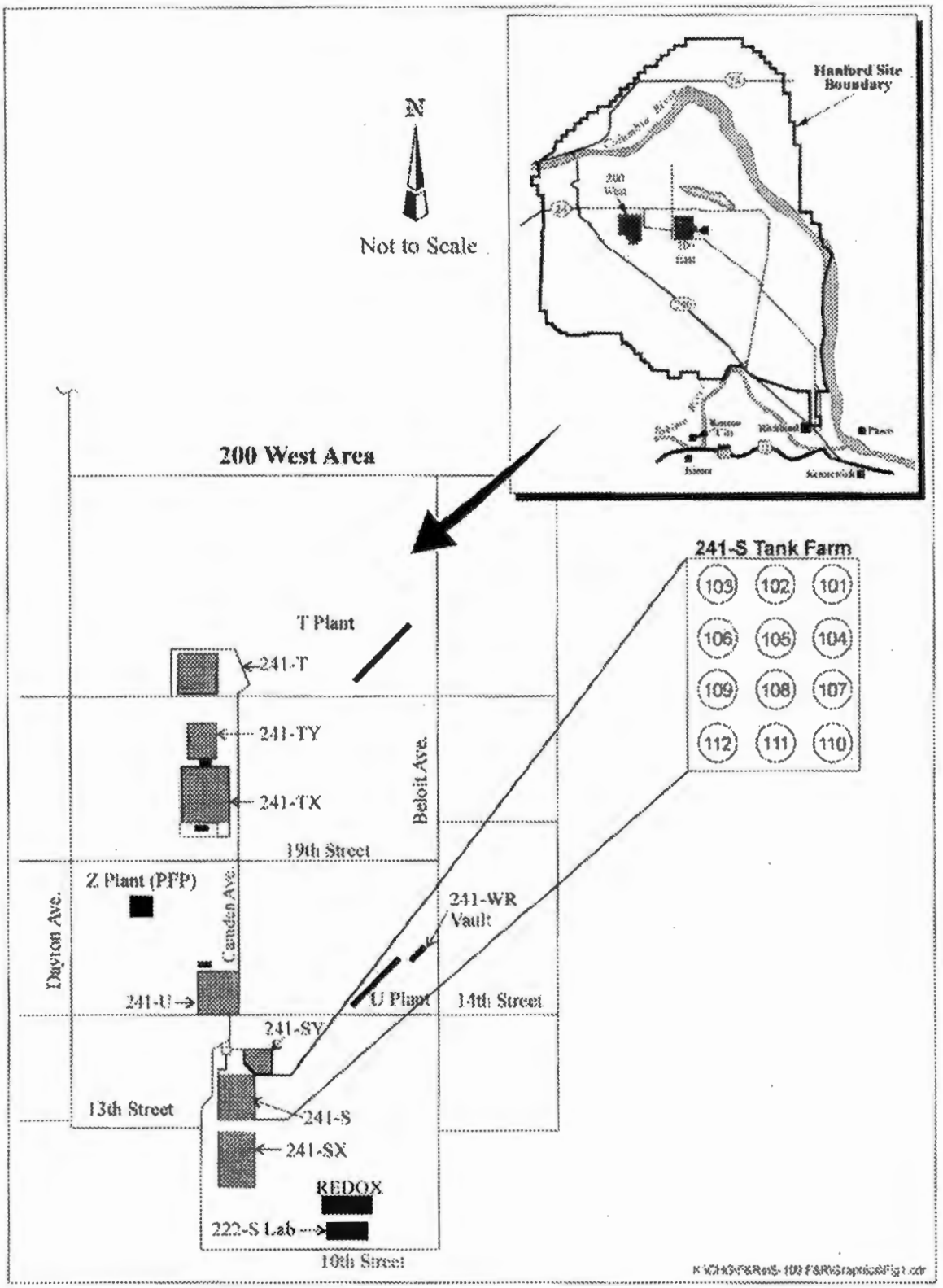
1.2 SCOPE

This document will establish the following:

- Waste retrieval F&R
- LDMM strategy
- Waste retrieval strategy for tank S-109.

Approval of this document will enable completion of the Phase 1and Phase 2 WRS design for tank S-109.

Figure 1. Location Map of S Tank Farm and Surrounding Facilities in the 200 West Area



The F&R identified in this document provide the foundation for the design criteria and design requirements documented in *System Specification for the 241-S-109 Waste Retrieval System* (RPP-18632). System specifications are used to communicate requirements that appropriately bound and constrain an item. The content of the system specifications will include detailed requirements such as operating pressures, temperatures, materials of construction and control system requirements, confinement boundaries and controls, interface requirements, and similar detailed application requirements. The system specification for tank S-109 will be consistent with this F&R document.

1.3 CURRENT TANK CONDITIONS

Tank S-109 was constructed between 1950 and 1951, and was put into service in the fourth quarter of 1952. Tank S-109 is one of twelve 100-series SSTs in the S farm. Tank S-109 is the third tank in a three-tank cascade. The tank is constructed with a dish-shaped bottom and an outer reinforced-concrete shell to maintain the structural integrity of the steel liner by protecting it from soil loads. The reinforced-concrete shell is cylindrical and supports the steel liner, which is constructed of carbon steel. Tank S-109 is 75 feet in diameter, has an operating depth of 22 feet, 11 inches, and has a capacity of 758,000 gallons (*Historical Tank Content Estimate for the Southwest Quadrant of the Hanford 200 West Area* [HNF-SD-WM-ER-352]).

As of June 2003, tank S-109 contained approximately 533,000 gallons of waste consisting of 520,000 gallons of salt cake including 16,000 gallons of interstitial salt cake liquid and 13,000 gallons of sludge. Specific volumes and constituents currently stored in tank S-109 are presented in Table 1. Tank S-109 is presently passively ventilated. Tank S-109 tank is categorized as "sound" (*Waste Tank Summary Report for Month Ending June 30, 2003* [HNF-EP-1082]; *Supporting Document for the Historical Tank Content for S-Tank Farm* [HNF-SD-WM-ER-323]).

Table 1. Tank S-109 Waste Volume and Inventory Summary

Tank S-109 Waste Type	Volume, gallons
Salt cake	520,000 including 16,000 gallons of interstitial liquid
Sludge	13,000
Total waste	533,000
Waste inventory	Units as noted
Cs-137	47,600 Ci
Sr-90	60,500 Ci
Tc-99	313 Ci
C-14	65.3 Ci
I-129	0.6 Ci
Pu-238,-239,-240,-241	147 Ci
Sodium	1,700,000 lb
Nitrate/Nitrite	4,263,000 lb

Waste inventory and volume data from DOE/ORP-2003-02.

Tank S-109 was constructed to store waste from the Reduction-Oxidation Extraction (REDOX) Plant. Primary additions to the tank consisted of REDOX high-level waste, REDOX cladding waste, water, REDOX salt cake, and partial neutralized feed (HNF-SD-WM-ER-352).

Figure 2 provides a plan view of waste management area S-SX and the surrounding *Resource Conservation and Recovery Act of 1976* groundwater monitoring wells. Groundwater monitoring activities will be consistent with the current *Resource Conservation and Recovery Act of 1976* monitoring plan (*RCRA Assessment Plan for Single-Shell Tank Waste Management Area S-SX at the Hanford Site* [PNNL-12114-ICN-1]). There are a number of drywells surrounding the 100-series tanks within the S tank farm (Figure 3).

2.0 RISK BASIS

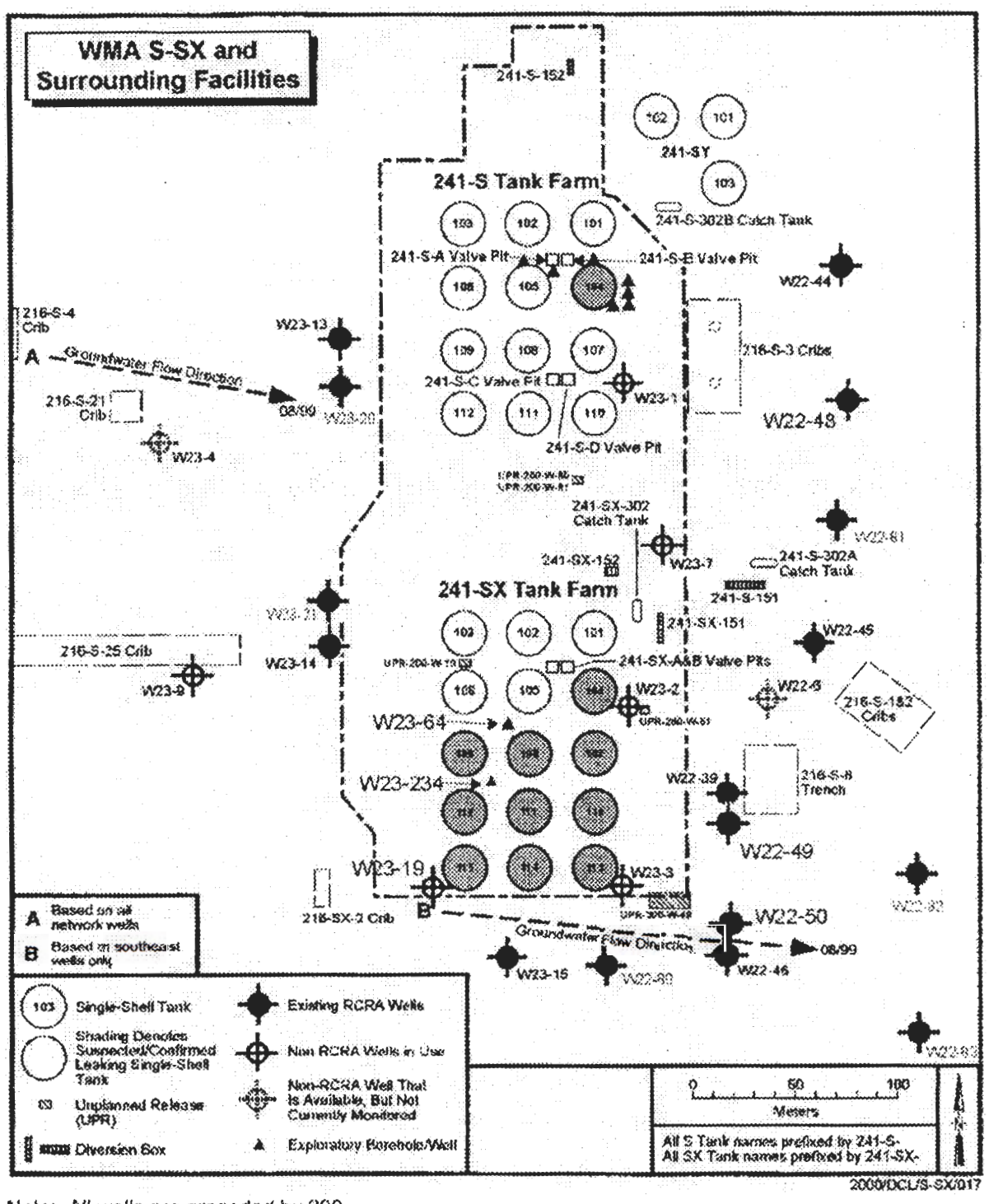
This section presents the results of a preliminary evaluation of the long-term human health risks associated with waste in tank S-109 and potential leaks that could occur during waste retrieval to support the TDF. The need to consider long-term human health risks in developing waste retrieval F&R was established in the HFFACO M-45 milestone series through Change Package M-45-00-01A. Milestones established by this change package required that a scoping-level risk assessment be prepared as part of the waste retrieval F&R documents. Scoping level is interpreted to be the same as a screening-level risk assessment that utilizes currently available data and information.

The risk basis for the tank S-109 partial waste retrieval is developed using estimated groundwater pathway human health risk. For this screening-level assessment, contaminant transport calculations are not performed. Rather, the effects of contaminant release and transport are taken from previous studies that are the most relevant to the case being studied. For tank S-109 Phase 1 and Phase 2, this is the vadose zone field investigation work for waste management area S-SX (*Field Investigation Report for Waste Management Area S-SX* [RPP-7884]).

A risk evaluation was performed to provide a basis for making informed decisions during waste retrieval operations in the event a leak is detected or unexpected retrieval conditions arise (*Tank S-109 Long-Term Human Health Risk Calculations* [RPP-19136]). The results of this evaluation are provided in Figure 4. The inventory associated with a hypothetical 8,000-gallon retrieval leak during partial waste retrieval activities is shown in Figure 4. The inventory associated with a hypothetical 8,000 gallon retrieval leak is calculated based on the recommendations in DOE/ORP-2003-02 (1.78×10^{-4} Ci/gal × 8,000 gal).

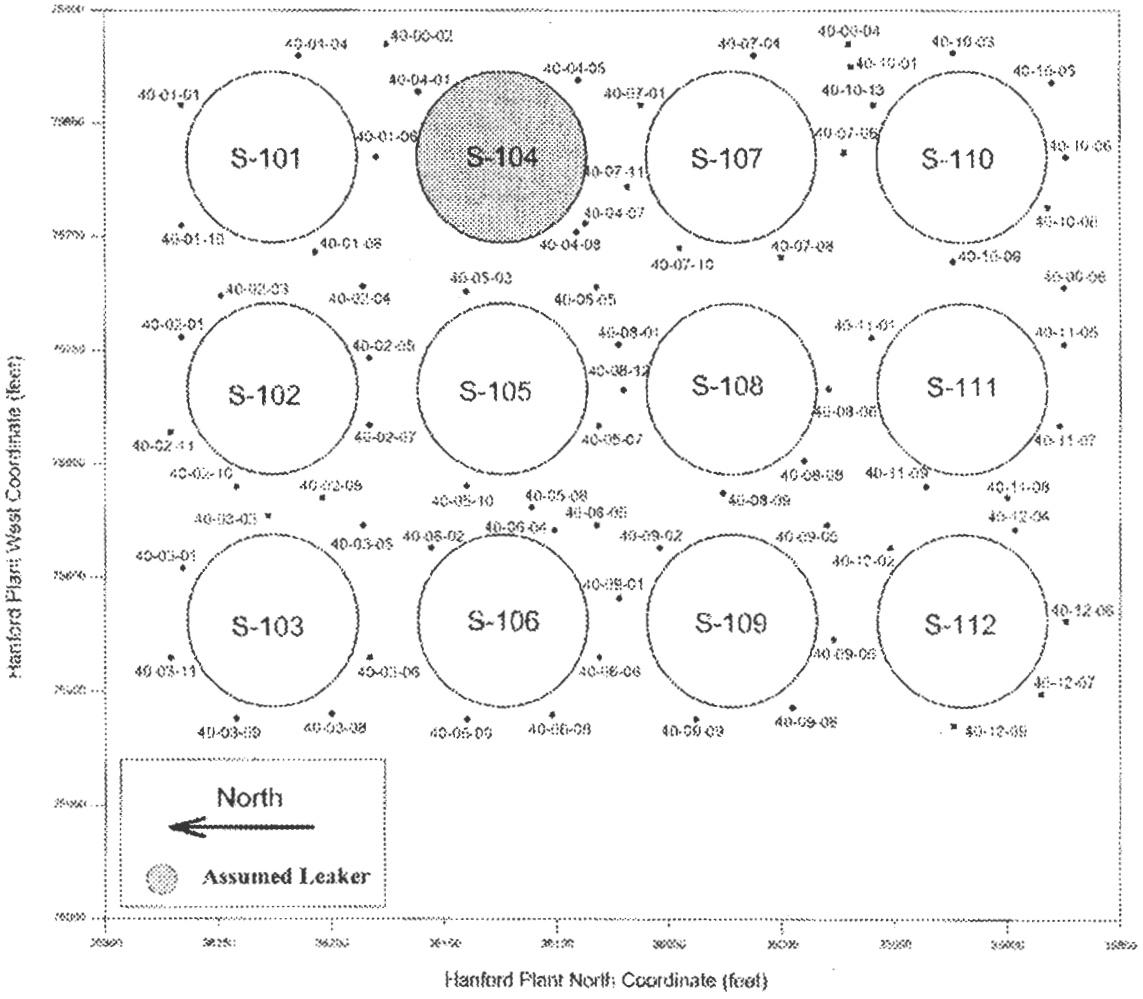
The methodology for this risk evaluation follows the guidance provided in *Contents of Risk Assessments to Support the Retrieval and Closure of Tanks for the Washington State Department of Ecology* (RPP-14284). Because this F&R document is limited to partial waste retrieval associated with Phase 1and Phase 2, only the risks associated with retrieval leaks are addressed. The risk assessment guidance document describes the technical basis for a streamlined risk assessment process that DOE and Ecology have agreed to use for purposes of preparing F&R documents. The main elements of the approach can be summarized as follows:

Figure 2. Waste Management Area S and Regulated Structures



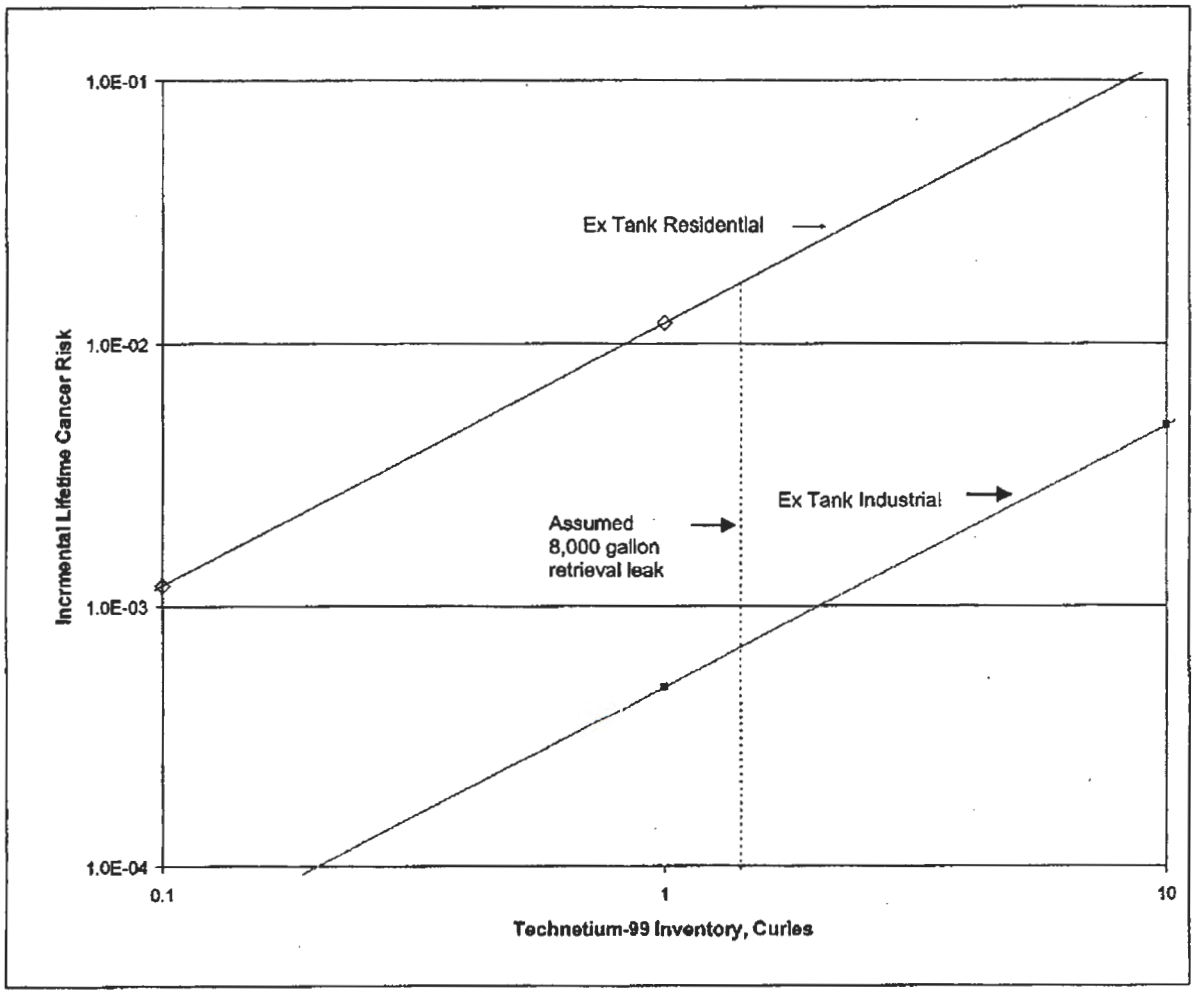
Note: All wells are preceded by 299-.

Figure 3. Plan View of the S Tank Farm Showing Drywells



- Focuses on potential long-term groundwater pathway human health risk at the tank farm fenceline
- Uses incremental lifetime cancer risk (ILCR) as the risk metric
- Provides ILCR for one indicator contaminant
- Derives effects of contaminant release and transport from previous studies; involves no new contaminant transport analysis
- Uses the best available existing data and information to the maximum extent possible, with little new data generated for the creation of the document.

Figure 4. Tank S-109 Risk Plot



Technetium-99 was selected as the indicator contaminant based on the results of a screening analysis. The analysis indicated that technetium-99 would contribute approximately 81% (industrial scenario) to 95% (residential scenario) of the total long-term groundwater pathway ILCR. The criterion used for the screening analysis was the calculated product of the residual

waste inventories from *Inventory and Source Term Data Package* (DOE/ORP-2003-02) and the ILCR conversion factors from *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment* (HNF-SD-WM-TI-707).

Contaminants included in the screening analysis were the long-lived mobile radionuclides that previous tank farm studies have shown contribute to peak ILCR. These were carbon-14, selenium-79, technetium-99, and iodine-129. Chemical carcinogens were disregarded because previous studies (e.g., *Single-Shell Tank S-112 Full Scale Saltcake Waste Retrieval Technology Demonstration Functions and Requirements* [RPP-7825]) have shown that cancer risk from radionuclides is more restrictive (e.g., lower residual waste volumes) than either the cancer risk from carcinogenic chemicals or the hazard index from noncarcinogenic chemicals. Cancer risks from radionuclides and chemicals typically are not summed because of differences in how risk is estimated for these two categories of substances.

Technetium-99 has been shown to be the driver for peak ILCR in previous tank waste studies (RPP-7884; *Field Investigation Report for Waste Management Area B-BX-BY* [RPP-10098]; *Hanford Immobilized Low-Activity Tank Waste Performance Assessment: 2001 Version* [DOE/ORP-2000-24]) as well as Hanford Site-wide studies (*Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site* [PNNL-11800]; *An Initial Assessment of Hanford Impact Performed with the System Assessment Capability* [PNNL-14027]).

Risk was calculated for this evaluation using the following equation.

$$R_i = I_i \times T_i \times d_i.$$

Where:

i = indicator contaminant
R_i = risk (ILCR)
I_i = inventory (Ci)
T_i = transport transfer function (pCi/L per Ci)
d_i = health effects conversion factor (ILCR per pCi/L).

Because the tank S-109 partial waste retrieval is intended to support technology demonstration and not tank closure, this evaluation addresses only the risk associated with a retrieval leak from tank S-109. Evaluation of the risk associated with tank S-109 residual waste, as well as the risks associated other S farm tanks, are deferred to the F&R document supporting tank S-109 final waste retrieval.

The tank S-109 waste retrieval leak technetium-99 inventory was calculated based on the data and recommendations in DOE/ORP-2003-02 by assuming that the waste retrieval leak fluid concentrations would be the same as the concentrations in the final residuals given in DOE/ORP-2003-02 (Table A.2). DOE/ORP-2003-02 (Table A.2) provides different residual inventory data sets for different assumed waste retrieval methods. The data set with the largest technetium-99 inventory value was used for this evaluation. For tank S-109, the Hanford Tank Waste Operations Simulator modeling data set was used.

A transport transfer function for ex-tank (potential retrieval leaks) waste was calculated from the results of a previous contaminant transport analysis by dividing the reported 10,000-year peak technetium-99 groundwater concentration at the tank farm fence line by the technetium-99 inventory released at the source. The ex-tank transfer function was calculated using waste management area S-SX past leak data from RPP-7884 as shown in Table 2.

Table 2. Ex-Tank (Potential Retrieval Leakage) Transport Transfer Function

Peak Technetium-99 Groundwater Concentration at S Tank Farm Fence line from Tank S-104 Past Leak (pCi/L)[a]	Technetium-99 Inventory in Tank S-104 Past Leak (Ci)[b]	Ex-Tank Transport Transfer Function (pCi/L per Ci)
1.38×10^5	3.87	3.57×10^4

[a]Source = RPP-7884, Table E-14.
[b]Source = RPP-7884, Table 3.4.

Risks were calculated for two exposure scenarios, industrial and residential. Both scenarios are based on scenarios described in *Hanford Site Risk Assessment Methodology* (DOE/RL-91-45). The health effects conversion factors for both scenarios were taken from tables provided in HNF-SD-WM-TI-707. The conversion factors provide the lifetime cancer morbidity risk per unit concentration of technetium-99 in the groundwater. The conversion factor values used for this evaluation are shown in Table 3.

Table 3. Health Effects Conversion Factors for Industrial and Residential Exposure Scenarios

Scenario	Technetium-99 Groundwater Unit Risk Factor (ILCR per pCi/L)
Industrial[a]	1.38×10^{-8}
Residential[b]	3.36×10^{-7}

[a]Source = HNF-SD-WM-TI-707, Rev. 3, Table 22.
[b]Source = HNF-SD-WM-TI-707, Rev. 3, Table 26.
ILCR = incremental lifetime cancer risk.

The industrial scenario represents 20 years of occupational exposure in an industrial setting. The receptor is an individual whose work activity is primarily indoors but also includes outdoor activities such as building and grounds maintenance. Contaminants enter the worker primarily through use of groundwater for drinking water and showering. External exposure to irrigated soil and soil inhalation are also included. The residential scenario represents 30 years of exposure in a residential setting. The receptor is an individual who resides on the land, grows fruits and vegetables, and raises livestock and poultry for personal consumption. Contaminants enter the receptor through use of groundwater for domestic needs (drinking, cooking, and

showering); for irrigation (ingestion of produce, soil, and water; inhalation of soil and water; and external exposure); and watering livestock (ingestion of meat, poultry, and dairy products).

Figure 4 presents a risk picture for tank S-109 but does not include contributions from other S tank farm sources. All sources in the S tank farm and waste management area S-SX will be included in the risk assessment supporting final closure of the S tank farm. Two separate ex-tank waste (retrieval leakage) curves are shown in Figure 4, one each for ex-tank waste (retrieval leakage) for the industrial and residential scenarios. The inventory of technetium-99 associated with a potential leak (ex-tank) of 8,000 gallons from tank S-109 is approximately 2 curies, which corresponds to a risk of approximately 7×10^{-4} (risk = 1.4 Ci × 3.57×10^{4} pCi/L per Ci [Table 2] × 1.38×10^{-8} ILCR/pCi/L [Table 3]) for the industrial scenario and 2×10^{-2} (risk = 1.4 Ci × 3.57 × 10^{4} pCi/L per Ci [Table 2] × 3.36×10^{-7} ILCR/pCi/L [Table 3])for the residential scenario.

3.0 FUNCTIONS AND REQUIREMENTS

This section establishes the upper-level functions and corresponding requirements to which the tank S-109 WRS for Phase 1and Phase 2 must be designed and operated. Other requirements not directly applicable at the level of detail in this F&R are disseminated to CH2M HILL Hanford Group, Inc. via DOE and CH2M HILL Hanford Group, Inc. Contract (Contract DE-AC-27-99RL14047). Additionally, the F&R ensures that waste retrieval actions do not result in adverse impacts to workers, the public, or the environment. Some of these requirements are derived from regulatory documents (e.g., *Code of Federal Regulations*, *Washington Administrative Code*) while others are based on the design constraints of tank S-109. The F&R are provided in Table 4 and are focused on driving the design of tank S-109 WRS.

Waste will be retrieved from tank S-109 and transferred to a DST in the SY tank farm or to the waste receipt tanks in the TDF. This document provides the F&R for the waste retrieval and transfer functions. The requirements for the waste receipt function will be addressed in other project documentation such as *Demonstration Bulk Vitrification Specification* (RPP-17403) and DOE/RL-2003-23 specific to the TDF.

4.0 LEAK DETECTION, MONITORING, AND MITIGATION, AND WASTE RETRIEVAL STRATEGY

This section describes the LDMM and waste retrieval strategy for tank S-109 WRS including definitions for LDMM, uncertainties in detecting and monitoring leaks in waste tanks, LDMM and retrieval strategy, and preliminary system descriptions. The F&R established in Section 3.0 of this document will govern the design and development of the integrated system.

LDMM terms are defined in *Annual Progress Report on the Development of Waste Tank Leak Monitoring/Detection and Mitigation Activities in Support of M-45-08 (TPA Milestone M-45-09E Fiscal Year 2000 Progress Report)* (RPP-7012). These definitions have been accepted by the Office of River Protection and Ecology and are presented here for reference:

Table 4. Tank S-109 Partial Waste Retrieval System Functions and Requirements (4 Sheets)

Function	Requirement	Basis	Key Elements
Maintain safe waste storage in tank S-109	The tank S-109 WRS shall control the structure and waste temperature in the tanks within established limits specified in the operating specification for single-shell waste storage tanks.	OSD-T-151-00013	Maximum 137 °C (280 °F) for waste and maximum 120 °C (250 °F) for dome
Maintain safe waste storage in tank S-109	The tank S-109 WRS shall prevent waste overflow into connected lines and limit hydrostatic head-induced stresses in the tank.	OSD-T-151-00013	Maintain waste level from exceeding 275 in. and minimize liquid level to the extent practical
Maintain safe waste storage in tank S-109	The tank S-109 WRS shall control the vapor space pressure in the tanks during retrieval within established limits specified in the operating specification for single-shell waste storage tanks.	OSD-T-151-00013	Minimum = (2.0 in. w.g. + [waste height (in.)] × [specific gravity of waste]); not to exceed 9 in. w.g.
Retrieve waste from tank S-109	The tank S-109 WRS shall be capable of retrieving waste at the rates and volumes necessary to feed the supplemental treatment demonstration.	RPP-17403	The WRS shall provide the capability to retrieve approximately 18,000 gallons every 8 days during Phase 2
Retrieve waste from tank S-109	The WRS shall have the capability to stage waste and monitor and/or sample the waste stream for concentrations and properties in order to meet the TDF waste feed requirements.	RPP-17403	Maximum allowable radionuclide concentrations, sodium concentration, chemical concentrations
Retrieve waste from tank S-109	The tank S-109 WRS shall be capable of retrieving waste from the specified tank and transferring the waste to the TDF receipt vessel.	RPP-17403	The WRS shall meet the interface requirements as specified in RPP-17403
Retrieve waste from tank S-109	The tank S-109 WRS shall be capable of transferring feed that fails to meet the TDF waste feed acceptance criteria to a DST in SY tank farm.	RPP-17403 SSTs are not suitable for storing liquid waste	Waste retrieved from tank S-109 that does not meet waste feed requirements will be transferred to a DST for storage

Table 4. Tank S-109 Partial Waste Retrieval System Functions and Requirements (4 Sheets)

Function	Requirement	Basis	Key Elements
Retrieve waste from tank S-109	The tank S-109 WRS shall provide the monitor and control capability to control the waste retrieval and transfer process. This includes controlling and monitoring the following S-109 process parameters as necessary: • Pressures • Flow rates • Radiation levels. The tank S-109 WRS shall provide instrumentation to support performing material balance calculations.	HNF-SD-WM-TSR-006 WAC 173-303	Provide for safe and effective operation of the WRS
Maintain safe waste storage in tank S-109	The tank S-109 WRS shall be designed for safe installation, operation, and maintenance.	29 CFR 1910 29 CFR 1926 10 CFR 835	OSHA standards Occupational Radiation Protection
Maintain safe waste storage in tank S-109	The tank S-109 WRS shall be designed to protect personnel and equipment from fires.	ORP M 420.1-1	Ensure safe operations
Maintain safe waste storage in tank S-109	The tank S-109 WRS waste transfer line flushing systems, and other raw water connections physically connected to waste transfer or process piping shall prevent contamination of the service water. At a minimum, the tank S-109 WRS raw water backflow prevention devices shall be designed to Washington State approved models and shall be accessible for inspection by a water purveyor in a nonradiological zone.	WAC 246-290-490 HNF-SD-WM-TSR-006	Mitigation of contamination spread in existing raw water lines
Retrieve waste from tank S-109	The tank S-109 WRS hose-in-hose transfer lines shall be designed in accordance with applicable requirements.	OSD-T-151-00010 HNF-SD-WM-TSR-006 WAC 173-303	Mitigate possible failure of hose-in-hose transfer line
Maintain safe waste storage in tank S-109	The tank S-109 WRS shall not impose loads on the tanks that exceed the dome loading limits.	HNF-IP-1266 TFC-ENG-FACSUP-C-10 RPP-11802	Mitigate possible structural failure of tank dome
Maintain safe waste storage in tank S-109	The tank S-109 WRS shall be designed to ensure proper structural strength, compatibility with the waste, and protection against corrosion.	WAC 173-303 HNF-SD-WM-TSR-006	Mitigate potential mechanical malfunction or failure of WRS components

Table 4. Tank S-109 Partial Waste Retrieval System Functions and Requirements (4 Sheets)

Function	Requirement	Basis	Key Elements
Maintain safe waste storage in tank S-109	For ex-tank equipment and piping, the WRS shall incorporate secondary containment and leak detection design features.	WAC 173-303 HNF-SD-WM-TSR-006	Provide for safe and compliant transfer of waste to the receiving tank/facility or to a DST
Retrieve waste from tank S-109	The ventilation system exhaust shall be filtered to restrict emissions to the environment.	WAC 173-400 WAC 173-460 HNF-IP-0842, Volume 6 WAC 173-480 WAC 246-247	Mitigate potential release to personnel, the public, and the environment
Retrieve waste from tank S-109	The tank S-109 WRS shall incorporate spill prevention and control design features.	40 CFR 265 WAC 173-303 HNF-SD-WM-TSR-006	Mitigate/minimize potential for, and amount of leak
Retrieve waste from tank S-109	The tank S-109 WRS shall have emergency stop features that will shut down the waste retrieval and the waste transfer systems.	WAC 173-303	Minimize environmental impacts and personnel risks
Retrieve waste from tank S-109	The S-109 WRS shall be designed and operated to protect workers, public, and the environment from exposure to radioactive tank waste and emissions during the retrieval campaign.	10 CFR 830 HNF-SD-WM-TSR-006 HNF-IP-1266 RPP-13033 DOE O 420.1A	Ensure protection of workers, the public, and the environment from routine and potential accident conditions
Retrieve waste from tank S-109	The tank S-109 WRS shall be capable of detecting liquid waste releases during all waste removal operations. The system shall be designed to detect leakage from the tank using the best available technology to detect tank leaks during retrieval.	WAC 173-303 HNF-SD-WM-TSR-006	Utilize best available LDM technologies coupled with mitigation strategies to minimize the potential for retrieval leakage; see Section 4.0
Retrieve waste from tank S-109	The WRS shall quantify liquid release volumes from S-109 if a release is detected during waste retrieval operations.	WAC 173-303	Utilize best available LDM technologies coupled with mitigation strategies to minimize the potential for retrieval leakage
Retrieve waste from tank S-109	The S-109 WRS shall minimize waste generation to the greatest extent practical, including water introduced into the tank.	WAC 173-303	No numerical requirement
Retrieve waste from tank S-109	The integrated retrieval and LDMM system shall be designed and operated to mitigate leaks as the primary means of minimizing environmental impacts from leaks.	HNF-SD-WM-AP-005	Leak mitigation strategy described in Section 4.0

Table 4. Tank S-109 Partial Waste Retrieval System Functions and Requirements (4 Sheets)

Function	Requirement	Basis	Key Elements
Retrieve waste from tank S-109	The WRS shall be designed for ease of decommissioning and disposal	10 CFR 835	Minimal holdup of material in waste transfer piping, piping, valves, pumps, and tanks that can be fully drained.
Retrieve waste from tank S-109	The WRS shall be designed to maintain worker exposure to radiation ALARA	10 CFR 835	Minimal holdup of material in piping, accommodation for shielding, and allowances for routine maintenance without the use of respirators.
Maintain safe storage in tank S-109	The tank shall meet established interim stabilization criteria following completion of Phase 2 waste retrieval activities.	Interim Stabilization Consent Decree (Ecology 1999)	Less than 5,000 gallons of supernate and less than 50,000 gallons of drainable interstitial liquid

CFR = *Code of Federal Regulations.*
DOE = U.S. Department of Energy.
DST = double-shell tank.
EPA = U.S. Environmental Protection Agency.
LDM = leak detection and monitoring.
LDMM = leak detection, monitoring, and mitigation.
ORP = Office of River Protection
OSHA = Occupational Safety and Health Administration.
SST = single-shell tank.
TDF = Test and Demonstration Facility.
WAC = *Washington Administrative Code.*
WRS = waste retrieval system.

- **Leak Detection**: technologies, methods, or systems used to detect a leak.

- **Leak Monitoring**: technologies, methods, or systems used to quantify liquid waste release volumes from an SST, if a release is detected during waste retrieval operations. Leak monitoring also includes assessment of leak monitoring data in an effort to estimate the rate and direction of movement through the soil.

- **Leak Mitigation**: technologies, methods, or systems that can reduce the potential for a leak to occur and action taken to minimize leak volumes in the event a leak is detected during waste retrieval.

4.1 LEAK DETECTION, MONITORING, AND MITIGATION STRATEGY

The integrated LDMM and waste retrieval strategy for the tank S-109 WRS has been developed to support providing waste feed to the TDF while considering the requirements specified in the HFFACO M-45 series of milestones. The purpose is to ensure that the waste retrieval and LDMM strategy:

- Is technically practicable and defensible
- Considers applicable regulations and requirements
- Minimizes waste releases to the environment should a leak occur
- Reduces the risk to human health.

4.1.1 Leak Mitigation Strategy

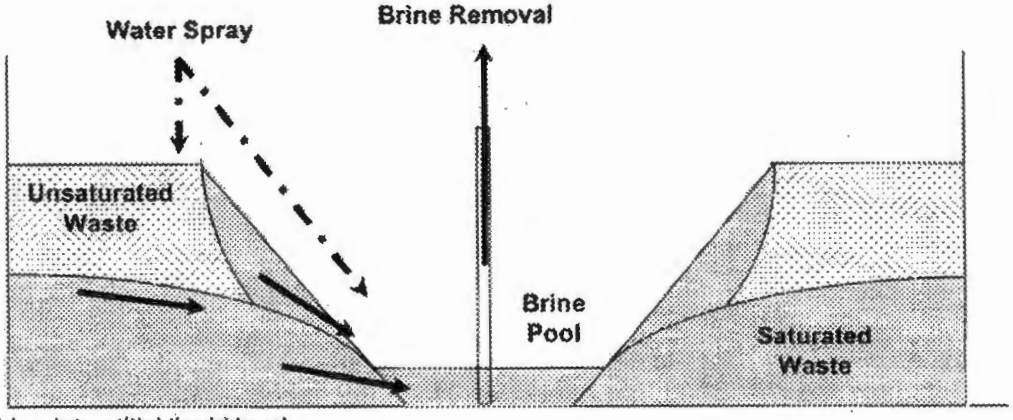
The primary goal of the tank S-109 LDMM strategy is leak mitigation (i.e., reduction of leak loss potential). The operational strategy takes actions to minimize liquid additions during waste retrieval.

The operational strategy to minimize the leak potential (initiation of a leak and leak volume) during waste retrieval in the absence of any indication of a leak involves the following:

- Limit the addition of water to only that volume necessary to dissolve sufficient salt cake to support the TDF. The specifics of the waste retrieval process will be developed during the design; however, the intent is to minimize the amount of drainable liquid in the tank during waste retrieval operations.

- Retrieving from advantageous location; given the limited number of risers in tank S-109, the system will be operated to focus on retrieving waste from the center region of the tank first during Phase 2 (Figure 5). This center-out waste retrieval strategy allows dissolved waste and released interstitial liquids to drain into a center pool, and can be pumped from the tank if a leak is detected. This strategy will minimize the amount of liquid that comes in contact with the tank walls, the location of most historical SST leaks, and will assist in the liquid collecting near the pump so the pump can operate from the lowest level in the tank consistent with the waste feed requirements of the TDF.

Figure 5. Illustration of Leak Mitigative, Center-Out Waste Retrieval Strategy



ILL = interstitial liquid level.

4.1.2 Leak Detection Strategy

The best practical and available leak detection methods will be used to monitor conditions in and around the tank for evidence of a tank or transfer line leak. The overall strategy for leak detection involves the following:

- During Phase 1, the existing drywells will be utilized as the primary leak detection method. A baseline will be established prior to initiating Phase 1 waste retrieval using the existing spectral gamma logging tools. Additionally as a defense-in-depth the interstitial liquid level in the tank will be monitored using the existing liquid observation wells (LOWs).

- During Phase 2 a high-resolution resistivity (HRR) leak detection system will be deployed for use as the primary LDM system. This technology is currently planned for demonstration deployment in the S and C tank farms prior to initiating Phase 2 activities at tank S-109. In the event that the HRR system does not prove satisfactory for use in the SST farms for leak detection, drywell monitoring will be used as the primary leak detection method. If drywell monitoring is used it will be supplemented with in-tank monitoring of the LOWs.

HRR long electrode LDM is currently planned for deployment at tank S-109. The HRR method uses geophysical resistivity measurement methods as a means to detect fluid leaks.
The electrical resistivity of the sediments beneath a waste tank depends on a number of parameters, one of which is moisture content. The leakage of water or tank waste into these sediments lowers the sediment resistivity. The HRR method detects a leak by comparing a current resistivity measurement against a previously obtained baseline measurement, or a "pre-leak" measurement. This delta processing allows the HRR method to "ignore" existing resistivity differences in the soil due to conductive structures, prior leaks, etc.

The basic resistivity measurement concept is a four-pole resistivity method. With the four-pole resistivity, two poles or electrodes are connected to a power source that injects a current in the soil. The resulting voltage gradient from this current is then measured with the second pair of

electrodes. This arrangement allows very small resistivity measurements to be made without impacting the measurement process (a high impedance measurement system is used with the system that has a minimum effect on the induced current field). By applying power to each electrode pair and while making resistivity measurements from all other electrode pairs, a "picture" of the sediment resistivity can be obtained that is an indicator of a leaked plume.

This technology has the potential to detect and spatially depict axial leaks as well as leaks beneath the tank, and is expected to provide an improved LDM over traditional in-tank and ex-tank leak detection methods. The viability of HRR as a leak detection method on SSTs is pending successful performance and evaluation of the planned demonstration and liquid injection leak testing (*Test Plan for SST Deployment Demonstration and Injection Leak Testing of the HRR Long Electrode LDM System* [RPP-17191]). Resistivity data from the HRR system will be collected and evaluated throughout Phase 2 waste retrieval operations. Leak detection thresholds will be established in the operating procedures.

4.2 SYSTEM DESCRIPTION

The waste retrieval and LDM systems described in this section represent an overview of the system currently planned for deployment in tank S-109. Modifications during fabrication and changes resulting from testing and deployment may change the system configuration as it is described herein. However, the final design shall comply with the requirements established in Section 3.0.

4.2.1 Partial Waste Retrieval System Description

The retrieval of waste from tank S-109 will occur in three separate phases. Partial waste retrieval will be performed in Phases 1 and 2 to support the TDF. The general approach to retrieving waste from tank S-109 during Phases 1 and 2 consists of a dissolution and pumping system (e.g., modified saltwell pumping system) to mobilize and retrieve waste. Conceptual level system descriptions are provided for only Phases 1 and 2 in this document. This document will be revised in the future to address retrieval of the balance of the waste in the tank during Phase 3.

During Phase 1, a salt cake dissolution process will be used to retrieve approximately 300 gallons of salt cake waste from the tank (approximately 1,000 gallons of brine) using the existing saltwell pumping system with some modification or a similar type system. The existing pumping system (with the pump turned off) or optionally a new water line will be used to introduce dissolution water locally around the saltwell. A liquid/solids separation system and a staging tank of approximately 1,000 gallons will be installed near tank S-109.

The waste in tank S-109 has been managed as high-level waste. HFFACO Milestone M-62-00 requires that high-level tank waste must be pretreated before treatment and disposal as immobilized low-activity waste. Pretreatment will be performed in the WTP pretreatment facility. However, since the WTP pretreatment facility will not be available to pretreat waste for the TDF, alternate methods of pretreatment will be utilized during waste retrieval for the demonstration project. Pretreatment of the tank S-109 waste consists of both historical and

partial waste retrieval activities. Historical waste management activities that contribute to pretreatment of the waste in tank S-109 include the following:

- Selection of a feed tank (S-109) containing waste that has been previously processed to reduce cesium-137 and strontium-90 concentrations.
- Reduction of the cesium-137 in tank S-109 through crystallization of the salt solution in the tank which concentrated the cesium-137 in the liquid phase for subsequent removal during interim stabilization.
- In tank liquid/solids separation, after initial placement of the waste in tank S-109 the sludge settled to the bottom of the tank and will not be retrieved during Phases 1 and 2.

During Phases 1 and 2, the following processes will provide additional pretreatment of the tank S-109 waste prior to transfer to the TDF:

- Reduction in cesium-137 concentration through removal of brine with high concentrations of cesium-137 and selective dissolution during the waste retrieval process.
- Liquid/solids separation process to minimize carryover of high-activity sludge inadvertently retrieved from the tank will be included as a part of the Phase 1 and Phase 2 WRSs. The separations process will allow any sludge inadvertently retrieved to be returned to the tank pending final retrieval.

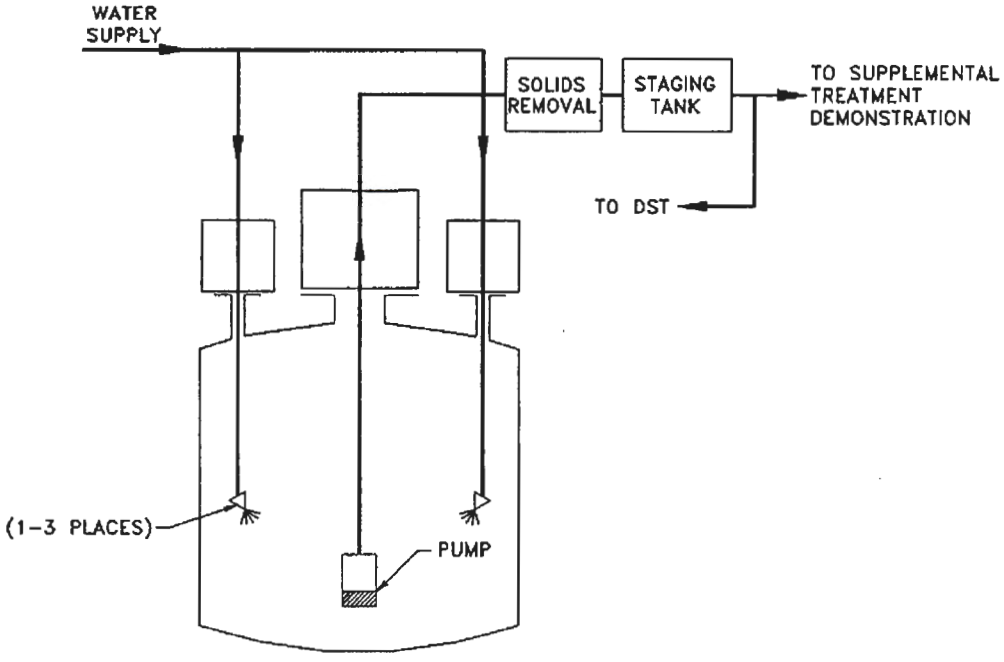
Because the TDF has specific limits on the waste feed the WRS will include provisions for waste sampling. Transfer routes will also be established to the SY tank farm for transferring waste from tank S-109 that does not meet the waste feed requirements of the TDF. The specifics of the system are under development and depend in part on the conditions of the existing system.

Following Phase 1 the WRS will be modified to support Phase 2 where a controlled sluicing process will be used to retrieve between 200,000 to 300,000 gallons of salt cake from the tank. The WRS envisioned for Phase 2 will include a pumping system, monitoring and control system, ventilation system, and water distribution system. The water distribution system will be installed in existing tank risers and will have the capability to direct water at various locations in the tank. The staging tank and solids removal equipment installed to support waste retrieval during Phase 1 will also be used during Phase 2.

Water used to calibrate instruments, check line connections, do leak tests, and flush back retrieved waste under an accident scenario will not be defined as a retrieval fluid if returned back to tank S-109. This will not constitute introduction of new waste into an SST.

A concept for the tank S-109 WRS during Phase 2 is depicted in Figure 6.

Figure 6. Phase 2-Controlled Sluicing Waste Retrieval System



4.2.2 Leak Detection and Monitoring System Description

During Phase 1 waste retrieval the existing truck mounted spectral gamma logging tools will be deployed in the drywell network around tank S-109. Additionally, the existing S-109 LOWs will be scanned using existing equipment and procedures.

The HRR system installed prior to Phase 2 will utilize the existing drywells around tank S-109 as the primary electrodes. The HRR system is not expected to require the addition of any new drywells. Cabling will be connected to a number of selected drywells. The cabling will then be routed to a single control station housing the resistivity instrumentation.

4.3 OPERATING STRATEGY

The operating strategy for performing LDMM and waste retrieval applies before, during, and after retrieval as described in the following sections. The strategy is consistent with the current level and maturity of the tank S-109 WRS design for Phase 1 and Phase 2, as well as the F&R established in Section 3.0.

4.3.1 Partial Waste Retrieval Operations

Phase 1 waste retrieval operations will consist of the controlled addition of dissolution water near the center of the tank. Prior to the addition of water, the pump will be operated to locally reduce the liquid level and create a cone of depression or gradient. The initial liquid removed from the tank is anticipated to exceed the waste feed limits for the TDF and will be transferred to the SY tank farm. Once the liquid level around the saltwell is lowered, water will be added to

dissolve the salt cake and the resulting brine will be pumped to the staging tank. During Phase 1, approximately one staging tank volume (approximately 1,000 gallons) will be pretreated and staged in the staging tank. After accumulation in the staging tank, the waste will be sampled for verification against the TDF waste feed requirements, then transferred to the TDF feed tank.

Phase 2 waste retrieval operations will consist of the controlled addition of dissolution water using water distribution nozzles. The waste retrieval operation will be oriented at retrieving waste from the center of the tank out. As the water penetrates the salt cake, the waste will be dissolved and mobilized toward the center of the tank where it will be pumped out. Once the waste is out of the tank it will undergo a liquids/solids separation step. Following the liquids/solids separation step the waste will undergo sampling and/or monitoring to verify acceptability at the TDF. Waste that does not meet the TDF waste feed requirements will be routed to the SY tank farm for storage. Following startup it is anticipated that the first few batches of waste accumulated in the staging tank will exceed the TDF waste feed requirements and will be transferred to the SY tank farm. The WRS will be designed to retrieve approximately 6,000 gallons of salt cake (18,000 gallons of feed solution) per week during Phase 2.

The overall retrieval operating strategy will consist of reducing the tank S-109 inventory of salt cake by up to 400,000 gallons while minimizing liquid hydrostatic head during waste retrieval operations, and monitoring for loss of liquid inventories while waste is actively being retrieved. The initial phase of waste retrieval activities will involve retrieving approximately 300-gallons of salt cake waste from the tank to support initial testing. The second phase will involve retrieval of additional waste in support of multiple treatment tests at the TDF. Additionally, up to 100,000 gallons of waste that does not meet the TDF acceptance criteria could be transferred to a DST.

4.3.2 Leak Detection and Monitoring Operations

Before initiating waste retrieval operations, a visual assessment of in-tank conditions will be performed using an in-tank camera. Because of the short duration for the Phase 1 waste retrieval, leak detection will consist of monitoring the drywells surrounding tank S-109 before and after Phase 1 waste retrieval operations. Additionally, as a defense-in-depth measure during Phase 1 operations, the LOWs within tank S-109 will be monitored as described in Section 4.1.2.

During Phase 2 operations, resistivity data will be collected and analyzed for changes in conditions that may provide indications of a leak. Resistivity change thresholds will be established in operating procedures.

4.3.3 Leak Mitigation Operations

If a leak is indicated during waste retrieval, response actions defined in the waste retrieval operating procedures will be implemented. The first response to an indication of a potential leak will be to validate the instrumentation. If the validation process concludes that no leak is indicated, waste retrieval operations will continue under normal operating procedures. However, if a leak is validated, the operating contractor will take actions to minimize the potential leak volume, place the equipment in a safe condition, and notify the Office of River Protection, which

will in turn notify Ecology. Pending formal direction from the Office of River Protection, the operating procedures will be used to determine the appropriate response action. Any response will consider the potential risk associated with the leak as described in Section 2.0 and the estimated leak rate. Potential response actions include the following:

- Modifying leak monitoring (e.g., implementing more frequent testing)
- Modifying operating conditions
- Discontinuing adding liquids
- Implementing emergency waste retrieval
- Stopping all tank S-109 waste retrieval operations.

The response actions would then be implemented and, if appropriate, waste retrieval operations would continue under modified procedures through the completion of the waste retrieval activities.

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