0060497

ENGINEERING CHANGE NOTICE

Page 1 of 6 ☒ DM ☐ FM ☐ TM

1a. ECN 720911 R 0

1b. Proj. ECN W- - R

2. Request Information	3a. Design Inputs -Record	3b. Design Outputs /	3c. Engineering Evaluation / Estimate /
Record Information on the ECN-1 Form	Information on the ECN-2 Form	References - Record Information on the ECN-3 Form	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
PM Branson	No. TF- - R- 7/27/03 CEG ☒ N/A ☐ Refer to Work Package	8/19/2003

7. Title	8. Bldg. / Facility No.	9. Equipment / Component ID	10. Approval Designator
Clarification of Leak Detection Methods	C-200/241-C	C-200 Series Tanks	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)

The second paragraph of the Leak Detection Strategy section, number 4.1.2 on page 19 of RPP-16525 R0 has been revised to clarify the intent of the leak detection strategy. There is no change to the technical approach to Leak Detection Strategy.

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OCT 08 2003
EDMC

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

This clarification is implemented because it reduces the level of ambiguity in the Leak Detection Strategy.

19. ***ECN Category***

☒ Direct Revision
☐ Supplemental
☐ Void/Cancel

ECN Type
☐ Supercedure
☐ Closure
☐ Change Prior

20. **Distribution**

Name	MSIN	Name	MSIN
EL Dalpiaz	S7-12	MC Tipps	S7-90
CJ Kemp	R1-51	PM Branson	S7-12
JS Boettger	S7-24	GL Crawford	S7-90
MN Jarayssi	H6-03	WT Thompson	S7-70
Central Files	B1-07		

Release Stamp

DATE: AUG 27 2003
STA: 3
HANFORD RELEASE
ID: 18

A-6003-563 (07/03)

ENGINEERING CHANGE NOTICE

☒ DM ☐ FM ☐ TM

1a. **ECN** 720911 **R** 0

1b. **Proj. ECN** W- - R

21. **Engineering Check** Record information on the ECN-6 Form as required	22. **Design Verification Required?** ☐ Yes ☒ No If Yes, as a minimum attach the one page checklist from TFC-ENG-DESIGN-P-17.	23. **Closeout / Cancel / Void** ☐ Yes ☒ No If Yes, Record information on the ECN-7 Form and attach form(s).

24. **Revisions Planned** (Include a brief description of the contents of each revision)

Section 4.1.2 Leak Detection Strategy, Paragraph 2, Page 19, sentence 1, Add 'tank waste' after 'The C-200 series', and add, 'tank waste' before 'leak and the potential environmental impact of a leak, should one occur.'

See continuation for additional change text.

Note: All Revisions shall have the approvals of the affected organizations as identified in block 10 "Approval Designator," on page 1 of this ECN.

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)
N/A	N/A

26a. **Design Cost Estimate**	26b. **Materials / Procurement Costs**	26c. Estimated Labor Hours
N/A	N/A	**N/A**

27. **Field Change Notice(s) Used?**

☐ Yes ☒ No

If Yes, Record information on the ECN-8 or ECN-9 Form, attach form(s), and identify permanent changes.

NOTE: ECNs are required to record and approve all FCNs issued. If the FCNs have not changed the original design media then they are just incorporated into the design media via an ECN. If the FCN did change the original design media then the ECN will include the necessary engineering changes to the original design media.

28. **Approvals**

Facility/Project Signatures		Date	A/E Signatures		Date
Design Authority	EL Dalpiaz E.L. Dalpiaz	8/21/03	Originator/Design Agent		
Team Lead/Lead Engr.	GL Crawford by telecom	8/19/2003	Professional Engineer		
Resp. Engineer	PM Branson	8/20/03	Project Engineer		
Resp. Manager	WT Thompson by telecom	8/19/2003	Quality Assurance	MC Tipps	
Quality Assurance	MC TIPPS	8/22/03	Safety		
IS&H Engineer			Designer		
NS&L Engineer			Environ. Engineer	CJ Kemp	8-25-03
Environ. Engineer			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					

ENGINEERING CHANGE NOTICE CONTINUATION SHEET	1a. ECN 720911 R 0
Page 3 of 6 ☒ DM ☐ FM ☐ TM	1b. Proj. ECN W- - R

Document/Drawing No. RPP-16525	Sheet N/A	Revision 0

(Note: A separate ECN Continuation page shall be used for each document/drawing to be modified.)

Section 4.1.2 Leak Detection Strategy, Paragraph 2, Page 19, The balance of the paragraph has been reordered and written as follows: 'As previously discussed, the waste retrieval system is designed to introduce water only as needed. The rate at which water is added is controlled, and the source is located next to the vacuum system intake. The vacuum system uses the water to mobilize the waste and remove it immediately from the tank. The small amount of liquid introduced into the tank and the short duration that the liquid will remain within the tank reduces or eliminates the ability to measure liquid levels for leak detection. Thus, static liquid observation wells cannot be employed. Also, drywell monitoring is not practical because there are currently no drywells located around the C-200 series tanks. If drywells were to be installed around the C-200 series tanks, they would have limited utility for leak detection because of the short waste retrieval durations and low water volumes. Therefore, the only viable approach that has been identified to detecting a leak is the mass balance approach. The following paragraphs present a more detailed discussion of each leak detection method considered for the C-200 series tanks. Conventional in-tank and ex-tank leak detection methods will be employed on the double-shell waste receiving tank, AN-106 (RPP-15230).'

Note: An AutoCAD page may be used in place of this form (the header section items must be included on the AutoCAD page).

ECN - 1 ENGINEERING REQUEST FORM	1a. ECN 720911 R 0
Page 4 of 6 ☒ DM ☐ FM ☐ TM	1b. Proj. ECN W- - R

Requestor's Name (Print)	*Date*	REA Reference
PM Branson	8/19/2003	N/A

Equipment Name	Estimated Need Date
C-200 series tanks	8/21/2003

Problem/Issue Statement

A clarification of Section 4.1.2 Leak Detection Strategy on page 19 of RPP-16525, Rev 0 is required.

Purpose for the Proposed Modification

Clarification provides less ambiguity in the planning process.

Basis for the Estimated Need Date

The document revision is required for ORP in response to DOE review cycle.

Requestor's Signature	*Date*
PM Branson [signature]	8/20/03

Responsible Engineering Manager Approval

Work Package Number (If Known)	Estimated Evaluation ROM Cost	*CACN*
N/A	$1000	BA00

Process as a Simple Modification? ☒ Yes ☐ No	*Assigned to (Team Lead)* GL Crawford	*Date* 8/17/2003
Responsible Engineering Manager (Print) WT Thompson	☒ Approve ☐ Reject	***Date*** 8/17/2003

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 Sheet 1 of ECN – 5 Page 5 of 6 ☒ DM ☐ FM ☐ TM	1a. ECN 720911 R 0 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-16525, Rev 0	C-200-Series Tanks 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 6 of 6

☒ DM ☐ FM ☐ TM

1a. ECN 720911 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
	☐ Yes	☐ No	☐ N/A		☐ Yes	☐ No	☐ N/A

C-200-Series Tanks Retrieval Functions and Requirements

B.E. Brendel
CH2M HILL Hanford Group, Inc.
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-99RL14047

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Abstract: N/A

Barbara Wolski 8/27/03

Release Approval   Date

AUG 27 2003
3

Release Stamp

Approved For Public Release

RECORD OF REVISION	(1) Document Number RPP-16525	Page 1

(2) Title
C-200-Series Tanks Retrieval Functions and Requirements

Change Control Record

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	 (6) Cog. Mgr. Date
1 RS	(7) Section 4.1.2, paragraph 2, page 19, revised	PM Branson 8/20/03	WT Thompon 8/26/03

A-7320-005 (10/97)

RPP-16525, Rev. 1

C-200-SERIES TANKS RETRIEVAL FUNCTIONS AND REQUIREMENTS

August 2003

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

EXECUTIVE SUMMARY

This document establishes the functions and requirements required by Milestone M-45-00 of the *Hanford Federal Facility Agreement and Consent Order*[1] for the retrieval of mixed waste stored in the C-200-series tanks. All four of the C-200-series tanks are designated as assumed leaking tanks and are located in the 200 East Area of the Hanford Site. The retrieval of waste from the C-200-series tanks will integrate leak detection, monitoring, and mitigation with retrieval technologies to minimize the potential for leaks to occur during retrieval and the leak volume should a leak occur.

The goals of this waste retrieval deployment are to remove waste to the limit of the technology, including the retrieval of 99% (no more than 30 cubic feet residual per tank) of tank contents by volume. Waste retrieval from the C-200-series tanks will utilize a vacuum-based retrieval process that introduces limited volumes of water to mobilize solids in the tanks that are then removed using vacuum as the motive force. Any water added would be in close proximity to the vacuum head, which will reduce the potential for liquid to pool within the tank.

This functions and requirements document establishes the C-200-series tanks waste retrieval system specifications (including leak detection, monitoring, and mitigation system specifications). The specifications are based on the use of best available technologies and consider environmental and human health risks associated with the tank waste and potential waste volumes that could leak during retrieval.

The waste retrieval system being deployed inherently reduces the potential for leakage to occur and 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 available process control data for performing mass balance leak detection within the C-200-series tanks.

[1] Ecology, EPA, and DOE, 1989, *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.

CONTENTS

FIGURES

TABLES

LIST OF TERMS

DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
F&R	function and requirement
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
ILCR	incremental lifetime cancer risk
LDM	leak detection and monitoring
LDMM	leak detection, monitoring, and mitigation
RCRA	*Resource Conservation and Recovery Act of 1976*
SST	single-shell tank
WRS	waste retrieval system

1.0 INTRODUCTION

The River Protection Project mission includes storage, retrieval, immobilization, and disposal of high-level 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. The C-200-series tanks (C-201, C-202, C-203, and C-204), located in the 200 East Area, are four of the tanks for which the schedule for waste retrieval has been accelerated (Figure 1). Because of the recent schedule acceleration, tank-specific waste retrieval milestones have not been established in the *Hanford Federal Facility Agreement and Consent Order* (HFFACO; Ecology et al. 1989) for the C-200-series tanks. However, this functions and requirements (F&Rs) document has been prepared to serve as a waste retrieval F&R document. This document follows a streamlined approach to developing waste retrieval F&R documents that was developed after issuing the F&Rs documents for waste retrieval in tanks C-104, S-102, and S-112.

Because of concerns related to the liquid containment integrity of the older SSTs, current plans call for retrieving the SST waste and staging it in the more reliable, *Resource Conservation and Recovery Act of 1976* (RCRA)-compliant, double-shell tanks (DSTs) to serve as feed material for the waste immobilization process. This retrieval step does not constitute closure. However, C-200-series waste retrieval activities will be conducted, to the extent practical, to meet requirements that allow ultimate closure of the tanks and the tank farm. Therefore, the steps taken to retrieve waste from the C-200-series tanks will not preclude any future closure decisions. The closure strategy will be defined in a closure plan for the C-200-series tanks that will be developed in the future.

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

1.1 PURPOSE

This document provides the F&Rs necessary to support the design of the WRS for the C-200-series tanks. This document also provides a preliminary strategy commensurate with the F&Rs for waste retrieval and LDMM. The strategy combines best available leak detection and monitoring (LDM) methods with an operational strategy designed to reduce the potential for leaks to occur and the resulting volume in the event a leak should occur.

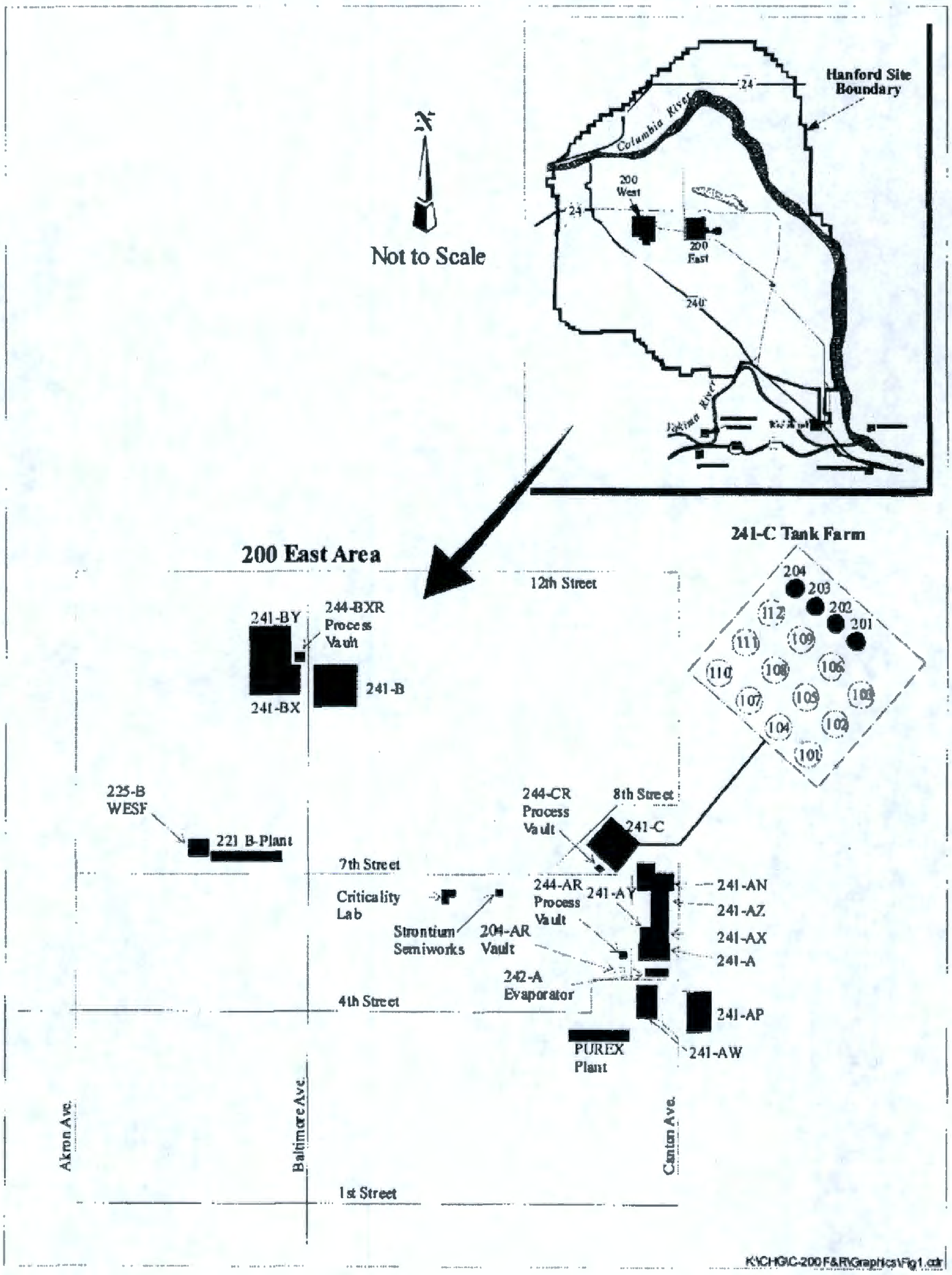
1.2 SCOPE

The scope of this document is to establish the following:

- Waste retrieval F&Rs
- LDMM strategy
- waste retrieval strategy for the C-200-series tanks.

Approval of this document will enable the WRS design to be finalized.

Figure 1. Location Map of C Tank Farm and Surrounding Facilities in the 200 East Area



The F&Rs identified in this document provide the foundation for the design criteria and design requirements documented in *Specification for the 241-C-200 Series Waste Retrieval System* (RPP-14075). Design specifications are used to develop the project engineering concepts, scope, and boundaries. The content of the design 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 design specifications for the C-200-series tanks will be developed during final design activities consistent with this F&Rs document.

1.3 C-200-SERIES TANKS CONDITION

The C-200-series tanks were constructed from 1943 to 1944 and were put into service in 1947 and 1948. The tanks are first-generation tanks constructed with a dish-shaped bottom, a painted grout layer, an asphalt (waterproof) membrane, 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 mild steel. The steel liner extends up the tank wall to a height of 25 feet (*Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area* [WHC-SD-WM-ER-349]). Tie lines between the C-200-series tanks were at the same elevation, which allowed them to overflow and equalize tank volumes.

As of January 2003, tank C-201 contained approximately 1,100 gallons of waste consisting of sludge; tank C-202 contained 800 gallons of waste consisting of sludge; tank C-203 contained 2,600 gallons of waste consisting of sludge; tank C-204 contained 2,400 gallons of waste consisting of sludge (*Characteristics of Waste in the C-200 Series of Hanford Underground Waste Tanks* [RPP-14627]). The C-200-series tanks are presently passively ventilated. The C-200-series tanks are categorized as "assumed leakers" (*Waste Tank Summary Report for Month Ending January 31, 2003* [HNF-EP-0182]). Further evaluation of available data has concluded that there is little if any technical basis for the reported leakage from the C-200-series tanks (*Inventory and Source Term Data Package* [DOE/ORP-2003-02]).

The first waste put into C-200-series tanks was metal waste from T Plant operations. Metal waste was accumulated and stored in C-200-series tanks until 1955, when the tanks were sluiced (WHC-SD-WM-ER-349). Following sluicing, C-200-series tanks were used to store a variety of wastes. These tanks were removed from service and declared inactive in 1977 (WHC-SD-WM-ER-349).

Figure 2 provides a plan view of the C tank farm and the surrounding RCRA groundwater monitoring wells. Groundwater monitoring activities will be consistent with the current RCRA monitoring plan (*RCRA Groundwater Monitoring Plan for Single-Shell Tank Waste Management Area C at the Hanford Site* [PNNL-13024]) and coordinated with other environmental monitoring as appropriate. There are a number of drywells surrounding the 100-series tanks within the C tank farm; however, there are no drywells surrounding the 200-series tanks (Figure 3).

Figure 2. Waste Management Area C and Regulated Structures

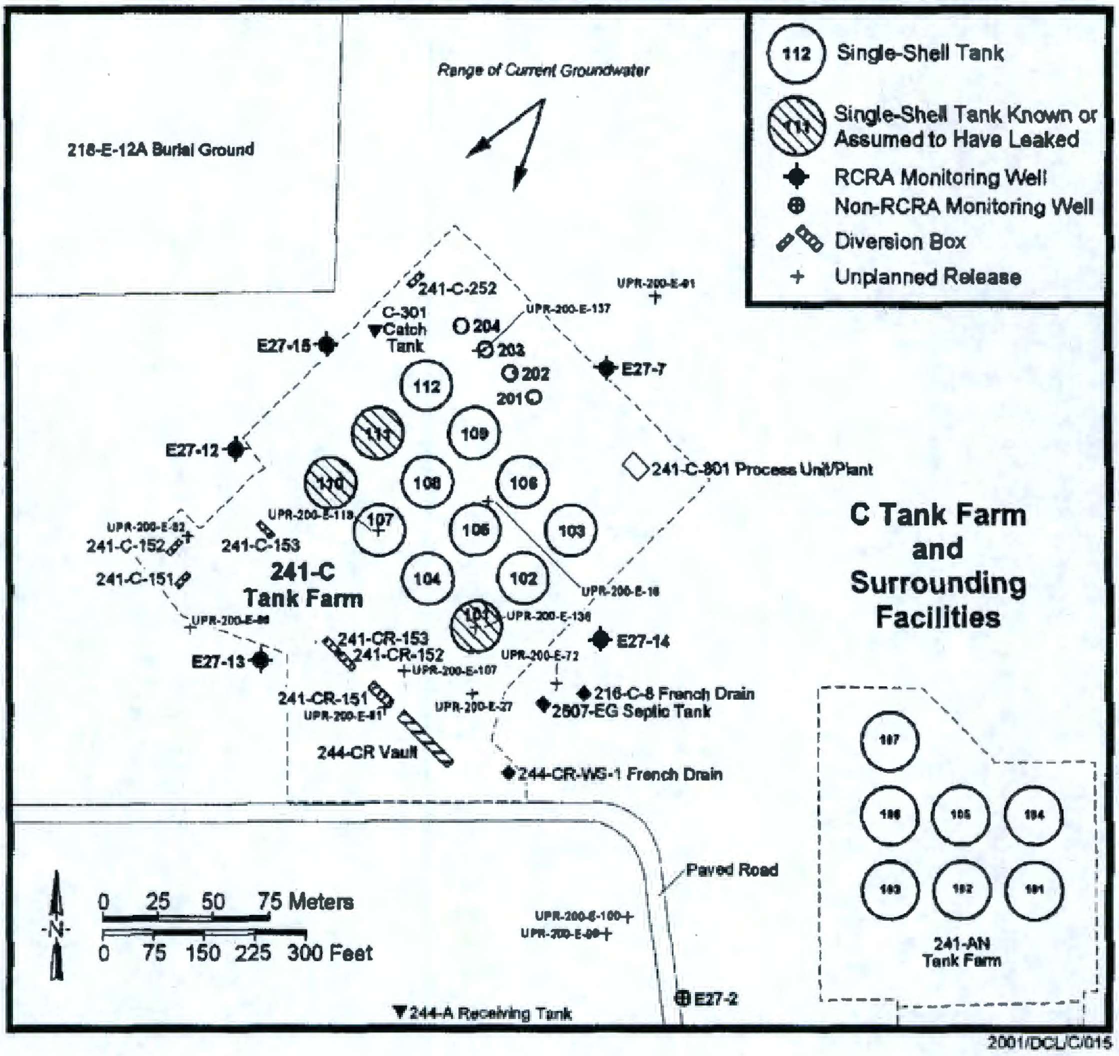
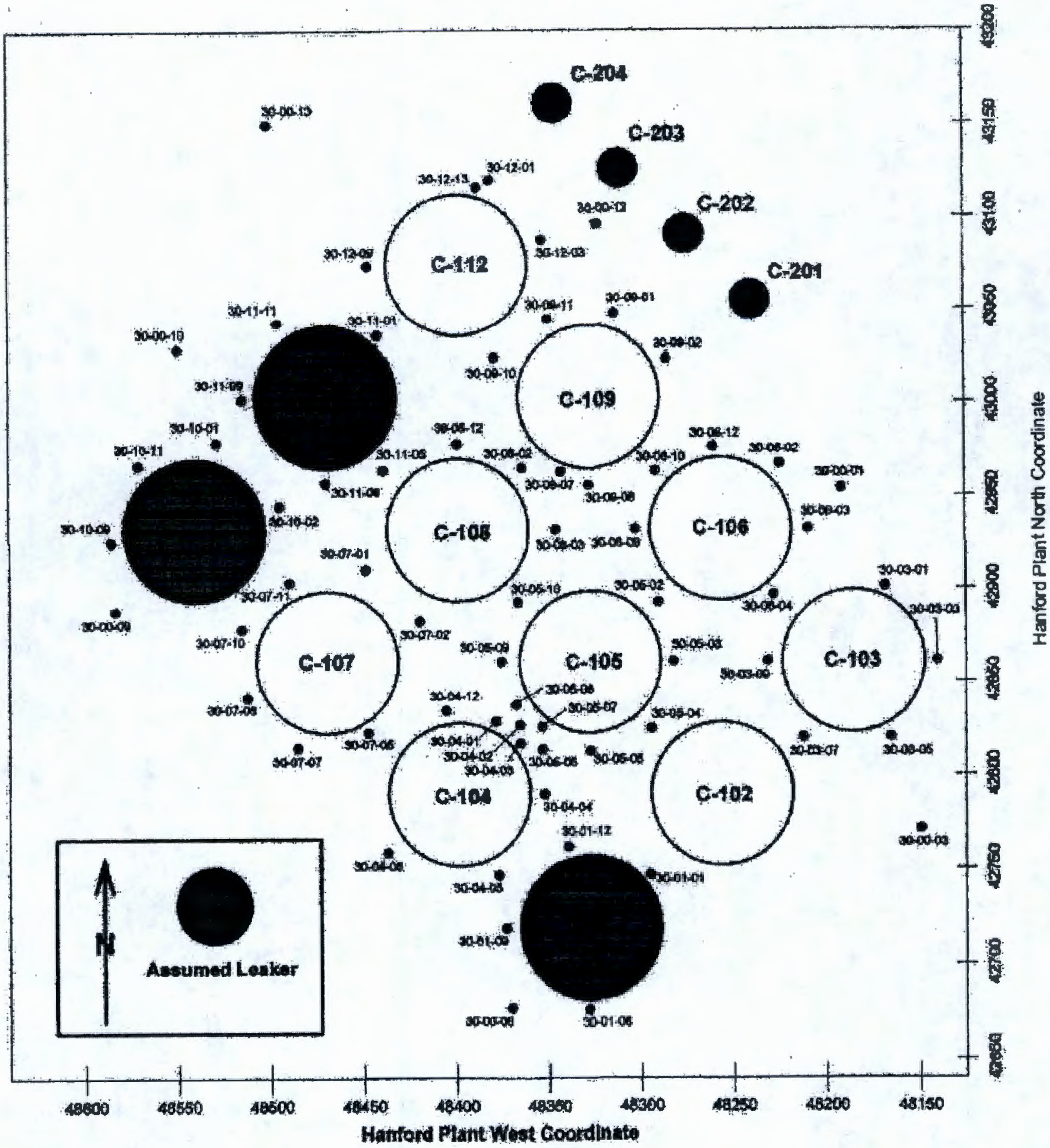


Figure 3. Plan View of the C Tank Farm Showing Drywells



Source: GJO-HAN-18.

2.0 RISK BASIS

This section presents the results of a preliminary evaluation of the long-term human health risks associated with waste in the C-200-series tanks and potential leaks that could occur during waste retrieval operations. The need to consider long-term human health risks in developing waste retrieval F&Rs 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&Rs 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 C-200-series tanks waste retrieval is extrapolated from *Data to Support Tank C-106 Waste Retrieval Determination* (RPP-6696) and *Field Investigation Report for Waste Management Area B-BX-BY* (RPP-10098).

DOE and the Washington State Department of Ecology (Ecology) have recognized that there are risks associated with retrieving waste from aging SSTs, including the potential for leakage during waste retrieval. However, DOE and Ecology have also recognized that there are risks associated with continued storage of waste in the SSTs. Not retrieving the waste will result in its eventual and certain release, when the tanks ultimately fail. The C-200-series tanks are approximately 35 years beyond their design life, and continued storage will increase the potential for leakage to occur during waste retrieval. Time will make the situation worse so there is a bias for action. Pending the availability of suitable storage for the waste and the availability of waste treatment capacity, there is an urgent need to retrieve and transfer waste from the aging SSTs to the safer, more reliable RCRA-compliant DSTs. The C-200-series tanks have been selected for accelerated waste retrieval.

The maximum volume of waste that could leak during waste retrieval operations is uncertain. This uncertainty is tied to the ability of the WRS to mobilize the waste from the tanks with minimal liquid volumes. The intent of deploying the vacuum based waste retrieval system is to retrieve waste without the addition of water; however, water additions may range from none to up to twice the volume of the waste in the tank, depending on waste make-up. Based on this range, the maximum liquid volume that would be added to any of the C-200-series tanks is approximately 2,600 gallons in tank C-203. Only a small fraction of this volume could leak from the tank due to the design of the WRS and the localized addition of liquids at the vacuum head.

Retrieval of all the waste from the C-200-series tanks with no leakage is the goal of the waste retrieval project. 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. The results of this evaluation are provided in Figure 4 and are based on the following:

- The methodology is based on the information and guidance provided in *Contents of Risk Assessments to Support the Retrieval and Closure of Tanks for the Washington State Department of Ecology* (RPP-14284). This document provides a technical basis for focusing the risk assessment on potential impacts to a receptor through the groundwater and the use of technetium-99 as the primary contaminant of concern for this assessment.

- The evaluation is based on the results of previous retrieval performance evaluation work for tank C-106 (RPP-6696) and the field investigation report for waste management area B-BX-BY (RPP-10098).

- The risk is measured at the tank farm fenceline using the industrial worker and residential farmer exposure scenarios.

- The risk metric is proportional to the technetium-99 inventory using a proportionality coefficient called the transport transfer function. Separate transport transfer functions are developed for waste that would remain inside the tanks (i.e., residual waste) and outside the tanks (i.e., past releases, potential retrieval leaks) at closure. Transport transfer functions for waste inside the tanks are developed from the tank C-106 evaluation (RPP-6696) by taking the incremental lifetime cancer risk (ILCR) results for 360 cubic feet (2,700 gallons) of tank residual waste and dividing this risk by the inventory of technetium-99 in this residual waste volume. Transport transfer functions for waste in the soil are developed from the waste management area B-BX-BY field investigation report data (RPP-10098) by taking the ILCR results for past operational releases in waste management area B-BX-BY and dividing these risk results by the inventory of technetium-99 in this source term.

- These transport transfer functions are used to represent the unit risk factor per curie of technetium-99 for the in-tank source term (tank residuals) and ex-tank source term (retrieval leakage and past leaks). The transport transfer functions are then multiplied by the estimated technetium-99 inventories associated with the C farm tanks to obtain ILCR estimates. The calculated transport transfer functions for in-tank waste are 4.5×10^{-8} ILCR/Ci (industrial worker) and 1.4×10^{-6} ILCR/Ci (residential farmer) and for ex-tank waste are 1.2×10^{-5} ILCR/Ci (industrial worker) and 4.2×10^{-4} ILCR/Ci (residential farmer).

- The technetium-99 inventories presented in Figure 4 for the current C-200-series tanks inventory and the inventory associated with different residual waste and retrieval leakage volumes are developed based on the data and recommendations presented in DOE/ORP-2003-02.

- Figure 4 presents a risk picture for the four C-200-series tanks combined but does not include contributions from other C tank farm sources. The four C-200-series tanks are considered as a single unit for the purposes of developing the risk plot because of the relatively small volume of waste in each of the tanks.

Four separate lines are shown in Figure 4, two for in-tank waste (residuals) for the industrial worker and residential farmer exposure scenarios and two for ex-tank waste (retrieval leakage) for the industrial worker and residential farmer exposure scenarios. As shown in Figure 4, the ILCR posed by the current inventory in the C-200-series tanks is approximately 5×10^{-9} for the industrial worker and 1×10^{-7} for the residential farmer; waste retrieval down to approximately 30 cubic feet in each C-200-series tank reduces the ILCR by approximately 1 order of magnitude. The inventory of technetium-99 associated with a potential leak (ex-tank) of 100 gallons from one of the C-200-series tanks (tank C-201) is approximately 0.0001 curies and corresponds to a risk of approximately 2×10^{-9} for the industrial worker and 6×10^{-8} for the residential farmer. A 100-gallon leak from each C-200-series tank increases the risk to approximately 8×10^{-9} for the industrial worker and 2×10^{-7} for the residential farmer. A 200-gallon leak from each C-200-series tank further increases the risk by approximately two times. For comparison, Washington State requires that the ILCR from carcinogenic chemicals not exceed 1×10^{-6} for individual contaminants and 1×10^{-5} for multiple contaminants ("The Model Toxics Control Act Cleanup Regulation" [WAC 173-340]). The U.S. Environmental Protection Agency requires the ILCR to be no higher than 1×10^{-4} ("National Oil and Hazardous Substances Pollution Contingency Plan" [55 FR 8666]).

To provide a perspective of the C-200-series tanks risk relative to other C farm tanks, the methodology described for evaluating the risk from the C-200-series tanks was applied to all the tanks in the C tank farm. The results of this evaluation are presented in Tables 1 and 2 for the industrial worker and residential farmer exposure scenarios, respectively. This methodology does not lend itself to developing a total or composite tank farm risk number but does allow for risk comparisons to be made between tanks and tank rows. Composite impacts at the C tank farm fenceline are presented for each of the four rows of tanks as the sum of the impacts from the tanks in that row. This approach is based on an assumption that long-term groundwater flow beneath the C tank farm will return to its pre-Hanford operations flow direction (i.e., to the southeast). Using this assumption, the plumes from the tanks within each row will overlap at the fence line but the plumes from each row will not have had time to overlap with adjacent rows by the time they reach the fence line.

The technetium-99 inventories presented in Tables 1 and 2 are based on the data and recommendations in DOE/ORP-2003-02. The residual waste inventories are for volumes of 360 cubic feet and 30 cubic feet for the 100- and 200-series tanks, respectively, and are based on the assumed use of a dry or minimal-liquid addition retrieval system for the C-200-series tanks and a sluicing-type retrieval system for the C-100-series tanks. For purposes of comparison, the waste retrieval leak inventories are based on assumed leak volumes of 8,000 gallons and 100 gallons for the 100- and 200-series tanks, respectively. Consistent with the information in DOE/ORP-2003-02, the past leak source term shown in Tables 1 and 2 reflects one leaking tank (tank C-105) in the C tank farm.

Figure 4. C-200-Series Tanks Risk Plot

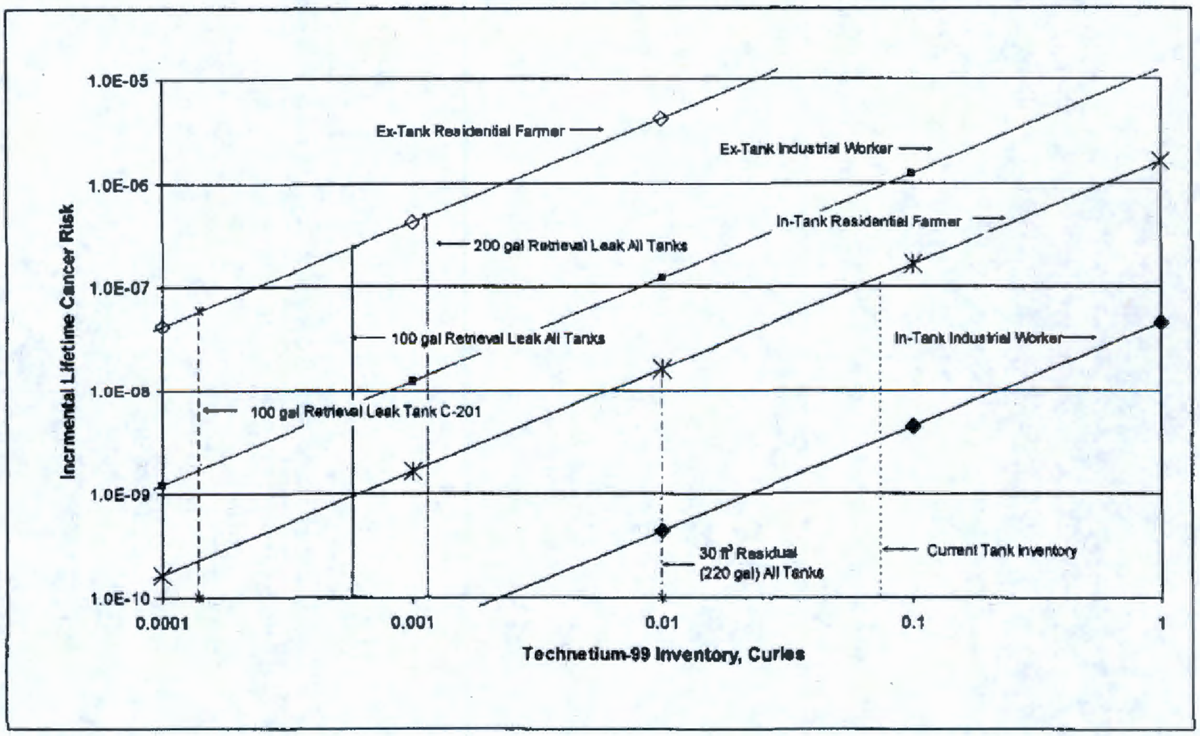


Table 1. C Tank Farm Risk Evaluation Results for Industrial Worker Scenario (2 Sheets)

Tank	Current Inventory	Residual Waste (360 ft³ [2,700 gal] C-100 Tanks, 30 ft³ [220 gal] C-200 Tanks		Assumed 8,000 gal (C-100 Tanks) or 100 gal (C-200 Tanks) Retrieval Leak		Past Leaks		Total (Post Retrieval)	
	Tc-99 (Ci)	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR
C-101	6.97E-01	2.70E-03	1.21E-10	8.01E-03	9.88E-08	0.00E+00	0.00E+00	1.07E-02	9.89E-08
C-102	1.33E+00	3.10E-03	1.38E-10	9.19E-03	1.13E-07	0.00E+00	0.00E+00	1.23E-02	1.14E-07
C-103	3.42E+01	4.28E-02	1.91E-09	1.27E-01	1.57E-06	0.00E+00	0.00E+00	1.70E-01	1.57E-06
C-104	5.80E+01	7.91E-02	3.53E-09	2.35E-01	2.89E-06	0.00E+00	0.00E+00	3.14E-01	2.90E-06
C-105	8.14E+01	1.25E-01	5.58E-09	3.70E-01	4.56E-06	1.93E+00	2.38E-05	2.43E+00	2.84E-05
C-106	3.14E+00	1.99E-01	8.89E-09	5.91E-01	7.29E-06	0.00E+00	0.00E+00	7.90E-01	7.30E-06
C-107	3.79E+01	6.81E-02	3.04E-09	2.02E-01	2.49E-06	0.00E+00	0.00E+00	2.70E-01	2.50E-06
C-108	6.19E+00	6.28E-02	2.80E-09	1.86E-01	2.30E-06	0.00E+00	0.00E+00	2.49E-01	2.30E-06
C-109	3.23E+01	2.56E-01	1.14E-08	7.59E-01	9.37E-06	0.00E+00	0.00E+00	1.02E+00	9.38E-06
C-110	3.18E+01	2.43E-01	1.09E-08	7.21E-01	8.90E-06	0.00E+00	0.00E+00	9.64E-01	8.91E-06
C-111	2.70E+00	1.97E-02	8.80E-10	5.85E-02	7.22E-07	0.00E+00	0.00E+00	7.82E-02	7.23E-07
C-112	6.11E+01	4.08E-01	1.82E-08	1.21E+00	1.50E-05	0.00E+00	0.00E+00	1.62E+00	1.50E-05
C-201	1.41E-02	2.99E-03	1.34E-10	1.41E-04	1.74E-09	0.00E+00	0.00E+00	3.13E-03	1.87E-09
C-202	1.47E-02	3.12E-03	1.39E-10	1.45E-04	1.79E-09	0.00E+00	0.00E+00	3.27E-03	1.93E-09
C-203	2.82E-02	2.40E-03	1.07E-10	1.45E-04	1.79E-09	0.00E+00	0.00E+00	2.55E-03	1.90E-09
C-204	1.81E-02	1.54E-03	6.88E-11	1.44E-04	1.78E-09	0.00E+00	0.00E+00	1.68E-03	1.84E-09
C-101 Row	1.28E+02	3.93E-01	1.75E-08	1.17E+00	1.44E-05	0.00E+00	0.00E+00	1.56E+00	1.44E-05
C-102 Row	9.16E+01	2.11E-01	9.41E-09	6.24E-01	7.70E-06	1.93E+00	2.38E-05	2.76E+00	3.15E-05

Table 1. C Tank Farm Risk Evaluation Results for Industrial Worker Scenario (2 Sheets)

Tank	Current Inventory	Residual Waste (360 ft³ [2,700 gal] C-100 Tanks, 30 ft³ [220 gal] C-200 Tanks		Assumed 8,000 gal (C-100 Tanks) or 100 gal (C-200 Tanks) Retrieval Leak		Past Leaks		Total (Post Retrieval)	
	Tc-99 (Ci)	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR
C-103 Row	1.31E+02	9.06E-01	4.05E-08	2.69E+00	3.32E-05	0.00E+00	0.00E+00	3.60E+00	3.32E-05
C-200 Row	7.51E-02	1.01E-02	4.49E-10	5.76E-04	7.10E-09	0.00E+00	0.00E+00	1.06E-02	7.55E-09
Total	**3.51E+02**	**1.52E+00**	**NA**	**4.48E+00**	**NA**	**1.93E+00**	**N/A**	**7.93E+00**	**NA**

C-101 row includes tanks C-101, C-104, C-107, and C-110.
C-102 row includes tanks C-102, C-105, C-108, and C-111.
C-103 row includes tanks C-103, C-106, C-109, and C-112.
C-200 row includes tanks C-201, C-202, C-203, and C-204.

ILCR = incremental lifetime cancer risk.
N/A = not applicable.

Table 2. C Tank Farm Risk Evaluation Results for Residential Farmer Scenario (2 Sheets)

Tank	Current Inventory	Residual Waste (360 ft^3 [2,700 gal] C-100 Tanks, 30 ft^3 [220 gal] C-200 Tanks		Assumed 8,000 gal (C-100 Tanks) or 100 gal (C-200 Tanks) Retrieval Leak		Past Leaks		Total (Post Retrieval)	
	Tc-99 (Ci)	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR
C-101	6.97E-01	2.70E-03	4.43E-09	8.01E-03	3.35E-06	0.00E+00	0.00E+00	1.07E-02	3.36E-06
C-102	1.33E+00	3.10E-03	5.08E-09	9.19E-03	3.85E-06	0.00E+00	0.00E+00	1.23E-02	3.85E-06
C-103	3.42E+01	4.28E-02	7.02E-08	1.27E-01	5.32E-05	0.00E+00	0.00E+00	1.70E-01	5.33E-05
C-104	5.80E+01	7.91E-02	1.30E-07	2.35E-01	9.83E-05	0.00E+00	0.00E+00	3.14E-01	9.84E-05
C-105	8.14E+01	1.25E-01	2.05E-07	3.70E-01	1.55E-04	1.93E+00	8.08E-04	2.43E+00	9.63E-04
C-106	3.14E+00	1.99E-01	3.26E-07	5.91E-01	2.47E-04	0.00E+00	0.00E+00	7.90E-01	2.48E-04
C-107	3.79E+01	6.81E-02	1.12E-07	2.02E-01	8.47E-05	0.00E+00	0.00E+00	2.70E-01	8.48E-05
C-108	6.19E+00	6.28E-02	1.03E-07	1.86E-01	7.81E-05	0.00E+00	0.00E+00	2.49E-01	7.82E-05
C-109	3.23E+01	2.56E-01	4.20E-07	7.59E-01	3.18E-04	0.00E+00	0.00E+00	1.02E+00	3.18E-04
C-110	3.18E+01	2.43E-01	3.98E-07	7.21E-01	3.02E-04	0.00E+00	0.00E+00	9.64E-01	3.03E-04
C-111	2.70E+00	1.97E-02	3.23E-08	5.85E-02	2.45E-05	0.00E+00	0.00E+00	7.82E-02	2.45E-05
C-112	6.11E+01	4.08E-01	6.69E-07	1.21E+00	5.08E-04	0.00E+00	0.00E+00	1.62E+00	5.08E-04
C-201	1.41E-02	2.99E-03	4.90E-09	1.41E-04	5.90E-08	0.00E+00	0.00E+00	3.13E-03	6.39E-08
C-202	1.47E-02	3.12E-03	5.11E-09	1.45E-04	6.09E-08	0.00E+00	0.00E+00	3.27E-03	6.60E-08
C-203	2.82E-02	2.40E-03	3.93E-09	1.45E-04	6.08E-08	0.00E+00	0.00E+00	2.55E-03	6.47E-08
C-204	1.81E-02	1.54E-03	2.52E-09	1.44E-04	6.03E-08	0.00E+00	0.00E+00	1.68E-03	6.28E-08
C-101 Row	1.28E+02	3.93E-01	6.44E-07	1.17E+00	4.88E-04	0.00E+00	0.00E+00	1.56E+00	4.89E-04
C-102 Row	9.16E+01	2.11E-01	3.45E-07	6.24E-01	2.61E-04	1.93E+00	8.08E-04	2.76E+00	1.07E-03

Table 2. C Tank Farm Risk Evaluation Results for Residential Farmer Scenario (2 Sheets)

Tank	Current Inventory	Residual Waste (360 ft^3 [2,700 gal] C-100 Tanks, 30 ft^3 [220 gal] C-200 Tanks		Assumed 8,000 gal (C-100 Tanks) or 100 gal (C-200 Tanks) Retrieval Leak		Past Leaks		Total (Post Retrieval)	
	Tc-99 (Ci)	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR	Tc-99 (Ci)	ILCR
C-103 Row	1.31E+02	9.06E-01	1.48E-06	2.69E+00	1.13E-03	0.00E+00	0.00E+00	3.60E+00	1.13E-03
C-200 Row	7.51E-02	1.01E-02	1.65E-08	5.76E-04	2.41E-07	0.00E+00	0.00E+00	1.06E-02	2.58E-07
Total	**3.51E+02**	**1.52E+00**	**NA**	**4.48E+00**	**NA**	**1.93E+00**	**N/A**	**7.93E+00**	**NA**

C-101 row includes tanks C-101, C-104, C-107, and C-110.
C-102 row includes tanks C-102, C-105, C-108, and C-111.
C-103 row includes tanks C-103, C-106, C-109, and C-112.
C-200 row includes tanks C-201, C-202, C-203, and C-204.

ILCR = incremental lifetime cancer risk.
N/A = not applicable.

3.0 FUNCTIONS AND REQUIREMENTS

This document establishes the upper-level functions and corresponding requirements to which the C-200-series tanks WRS must be designed and operated. Other requirements not directly applicable at this level of functional decomposition are disseminated to CH2M HILL Hanford Group, Inc. via the DOE-CH2M HILL Hanford Group, Inc. Contract (Contract DE-AC-27-99RL14047). Specifically, the F&Rs included in this document are derived from the need to satisfy the HFFACO Milestone M-45-00 requirements to retrieve as much tank waste as technically possible, with tank waste residues not to exceed 30 cubic feet, or the limit of the waste retrieval technology, whichever is less. Some of these requirements are derived from the regulatory documents, such as the *Code of Federal Regulations* and the *Washington Administrative Code*, while others are based on the design limitations of the C-200-series tanks and the DST receiver tank. The F&Rs are provided in Table 3 and are focused on appropriately driving the design of the C-200-series WRS so that the aforementioned requirements are met. These F&Rs are consistent with RPP-14075.

4.0 LEAK DETECTION, MONITORING, AND MITIGATION AND RETRIEVAL STRATEGY

This section describes the LDMM and waste retrieval strategy for the C-200-series tanks WRS, including definitions for LDMM, uncertainties in detecting and monitoring leaks, LDMM and waste retrieval strategy, and preliminary system descriptions. LDMM activities 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:

- **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, waste retrieval methods, or systems that can reduce the potential for a leak to occur, the volume of a leak if it were to occur, and action taken to minimize leak volumes in the event a leak is detected during waste retrieval.

Table 3. C-200-Series Tanks Waste Retrieval System Functions and Requirements (3 Sheets)

Function	Requirement	Basis	Key Elements
Control structure and waste temperature in C-200-series tanks	Maintain tank structure and waste temperature within limits defined in SST operating specification.	OSD-T-151-00013	Maximum 137 °C (280 °F) for waste and maximum 120 °C (250 °F) for dome
Control C-200-series tank waste level	Prevent waste overflow and limit hydrostatic head-induced stresses in the tank.	OSD-T-151-00013 Good engineering practice	Maintain waste level from exceeding 280 in. and minimize liquid level to the extent practical
Control vapor space pressure in the C-200-series tanks	Maintain vapor space pressure within limits defined in SST operating specification.	OSD-T-151-00013	Minimum = -(5.3 in. w.g. + [waste height (in.)] × [specific gravity of waste]); not to exceed -9 in. w.g. Maximum = +4 in. w.g.
Control gaseous discharges from the C-200-series tanks	The ventilation system exhaust shall be filtered to restrict radioactive emissions to the environment.	WAC 173-400 WAC 173-460 HNF-IP-0842, Volume 6, Section 1.7	Maintain minimum vacuum of 0.3 in. w.g. and filter exhaust stream before discharge
Remove waste from the C-200-series tanks	The C-200-series WRS shall be capable of removing as much waste as technically possible, with tank waste residues not to exceed 30 ft^3, or the limit of the waste retrieval technology, whichever is less. If DOE believes that waste retrieval to these levels is not possible for a tank, DOE will submit a detailed explanation to EPA and Ecology explaining why these levels cannot be achieved, and specifying the quantities of waste that DOE proposes to leave in the tank. The request will be approved or disapproved by EPA and Ecology on a case-by-case basis.	HFFACO Milestone M-45-00	The WRS shall provide the ability to retrieve waste to less than 30 ft^3

Table 3. C-200-Series Tanks Waste Retrieval System Functions and Requirements (3 Sheets)

Function	Requirement	Basis	Key Elements
Control and monitor the waste removal process in the C-200-series tanks	The C-200-series WRS shall provide the monitor and control capability to control the waste retrieval and transfer process. This includes controlling and monitoring the following C-200-series WRS process parameters: • Pressures • Flow rates • Differential pressures across filters • Leak detection systems • Radiation monitoring systems. The C-200-series WRS shall be operated remotely, have video monitoring capabilities, and provide instrumentation to support performing material balance calculations.	Good engineering practice HNF-SD-WM-TSR-006, AC 5.12	Provide for safe and effective operation of the WRS
Detect leaks during waste removal from the C-200-series tanks	The 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 to as low as reasonably achievable.	40 CFR 265	Utilize best available LDM technologies coupled with mitigation strategies to minimize the potential for retrieval leakage; see Section 4.0
Monitor leaks from the C-200-series tanks during waste removal	The WRS shall quantify liquid release volumes from the C-200-series tanks if a release is detected during waste retrieval operations.	Good engineering practice	Utilize best available LDM technologies coupled with mitigation strategies to minimize the potential for retrieval leakage
Measure and estimate residual waste in the C-200-series tanks	The WRS design shall allow for estimating the residual waste in the C-200-series tanks following retrieval operations.	HFFACO, Appendix H	Design feature
Minimize waste generation	The WRS shall minimize waste generation to the greatest extent practical, including water introduced into the tank.	Good engineering practice	No numerical requirement

Table 3. C-200-Series Tanks Waste Retrieval System Functions and Requirements (3 Sheets)

Function	Requirement	Basis	Key Elements
Mitigate leaks during the C-200-series waste retrieval	The integrated retrieval and LDM system shall be designed and operated to mitigate leaks as the primary means of minimizing environmental impacts from leaks during retrieval if they occur. The primary means of mitigation shall be through removal of free liquid as rapidly as feasible using the equipment described in this document.	HNF-SD-WM-AP-005 Good engineering practice	Leak mitigation strategy described in Section 4.0
Nuclear safety	The WRS shall be designed and operated to protect workers, public, the environment, and equipment from exposure to radioactive tank waste and emissions during the retrieval campaign.	HNF-5183 WAC 246-247 10 CFR 830	Ensure protection of workers and the public from routine and potential accident conditions
Maintain design and operating limits for DST used as a receiver tank	The WRS shall not adversely affect the function of the DST system or exceed the DST design and operational limits.	HNF-SD-WM-TSR-006, LCO 3.3.2 HNF-SD-WM-TRD-007	Ensure safe and effective receipt and storage of the C-200-series tank waste in receiver DST
Occupational safety and health	The WRS shall incorporate design features that comply with the requirements of 29 CFR 1910.	29 CFR 1910 10 CFR 835	OSHA standards
SST and DST dome loading	The WRS shall not exceed the maximum dome loading on existing SSTs and DSTs specified in HNF-SD-WM-SAR-067.	HNF-IP-1266 HNF-SD-WM-SAR-067 TFC-ENG-FACSOP-C-10	Mitigates possible structural failure of tank dome
WRS secondary containment and leak detection	For ex-tank equipment and piping, the WRS shall incorporate secondary containment and leak-detection design features in accordance with 40 CFR 265.193, WAC 173-303-640(4), and DOE O 435.1.	40 CFR 265 WAC 173-303 DOE O 435.1	Provide for safe and compliant transfer of waste to the receiver DST

CAM = continuous air monitor.
DOE = U.S. Department of Energy.
DST = double-shell tank.
Ecology = Washington State Department of Ecology.
EPA = U.S. Environmental Protection Agency.
HFFACO = *Hanford Federal Facility Agreement and Consent Order*.
LCO = Limiting Condition for Operation.
LDM = leak detection and monitoring.
OSHA = Occupational Safety and Health Administration.
SST = single-shell tank.
WRS = waste retrieval system.

4.1 LEAK DETECTION, MONITORING, AND MITIGATION STRATEGY

The integrated LDMM and waste retrieval strategy for the C-200-series tanks has been developed to meet the requirements specified in the HFFACO M-45 series milestones and manage the risk posed by potential waste leakage during waste retrieval operations. The purpose is to ensure that the C-200-series tanks waste retrieval and LDMM strategy:

- Is technically practicable and defensible
- Complies with applicable regulations and requirements
- Meets the programmatic needs of the Office of River Protection
- Utilizes the best available LDMM technologies and strategies
- Minimizes waste releases to the environment should a leak occur
- Reduces the risks to human health.

4.1.1 Leak Mitigation Strategy

The primary goal of the C-200-Series Tanks Project LDMM strategy is leak mitigation (i.e., reduction of leak loss potential) and is two-fold. The operational strategy takes actions to minimize liquid available for leakage from the onset of retrieval and to minimize the time at risk (*C-200 Series Tanks Retrieval Leak Detection, Monitoring, and Mitigation Strategy White Paper* [RPP-15230]).

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 (RPP-15230):

- Limit the volume of liquid in the tank. The selected WRS uses a vacuum-driven air conveyance system deployed on an articulating mast to remove the waste from the tanks. No standing water is required in the tank for this system to operate. The system will vacuum up any free liquids.

- If the sludge is too stiff to be removed by the vacuum system a high-pressure, low-volume water jet will be used to dislodge/breakup the waste for removal. The mining strategy will use the water jet for a short time then quickly vacuum up loosened waste and any free liquids observed so they will not be available to leak. The water jet is attached directly to the vacuum nozzle so that any water used to mobilize the sludge will immediately be removed.

- The time at risk (waste retrieval duration) will be low as the retrieval time for each C-200-series tank is projected to be approximately 10 days.

4.1.2 Leak Detection Strategy

The C-200-Series Tanks Project has evaluated both in-tank and ex-tank methods that have been used historically for leak detection. To be a suitable candidate for full-scale deployment, LDM technologies must be technically mature and capable of being deployed in a manner that supports the waste retrieval schedule and operational performance and reliability requirements (RPP-15230).

The C-200 series tank waste retrieval systems and waste retrieval strategy have been designed to reduce the possibility of a tank waste leak and the potential environmental impact of a leak, should one occur. As previously discussed, the waste retrieval system is designed to introduce water only as needed. The rate at which water is added is controlled, and the source is located next to the vacuum system intake. The vacuum system uses the water to mobilize the waste and remove it immediately from the tank. The small amount of liquid introduced into the tank and the short duration that the liquid will remain within the tank reduces or eliminates the ability to measure liquid levels for leak detection. Thus, static liquid observation wells cannot be employed. Also, drywell monitoring is not practical because there are currently no drywells located around the C-200 series tanks. If drywells were to be installed around the C-200 series tanks, they would have limited utility for leak detection because of the short waste retrieval durations and low water volumes. Therefore, the only viable approach that has been identified to detecting a leak is the mass balance approach. The following paragraphs present a more detailed discussion of each leak detection method considered for the C-200 series tanks. Conventional in-tank and ex-tank leak detection methods will be employed on the double-shell waste receiving tank, AN-106 (RPP-15230).

4.1.2.1 Static Liquid Level Observation

Leak detection in SSTs has historically been based on liquid level monitoring. Static liquid level monitoring works well if the tank being retrieved and the receiver tank both have a liquid surface that can be accurately measured and used to estimate waste inventory in both tanks. No free liquids will typically be available in the C-200-series tanks during waste retrieval operations (RPP-15230). The use of the vacuum retrieval system will reduce leakage potential and will not allow for liquid level monitoring during retrieval operations. Static level monitoring will be used for leak detection in receiver tank AN-106 (RPP-15230). It should be noted that the addition of the waste from any one of the C-200-series tanks would raise the level in tank AN-106 by 2 inches or less.

4.1.2.2 Mass Balance

The mass balance approach uses process control data to compare liquid added to the tank to liquid removed from the tank (i.e., liquid pumped out of the tank and potentially the water vapor losses from the tank exhauster). A running total of volume of liquid added to the tank and dilution water added for transfer conditioning will be compared to the liquid fraction of the waste pumped into the transfer line using process control data to reveal a gross deficit due to possible leakage (RPP-15230).

Of the three leak detection methods described, mass balance is the only method that is a candidate for deployment in the C-200-series tanks. Mass balance will be utilized throughout the waste retrieval campaign; however, the uncertainties associated with mass balance methods for leak detection are larger than the anticipated volume of liquid that might be added to each tank for waste retrieval. Because the volume of liquid added to any of the C-200-series tanks is relatively small, it is anticipated that leakage of these volumes would not be measurable.

Static level detection can be used for mass balance calculations in receipt tank AN-106. Flow meters on the vacuum retrieval system transfer piping will provide mass balance input from the C-200-series tanks (RPP-15230).

4.1.2.3 Ex-Tank Leak Detection

Available ex-tank leak detection methods involve indirect measurement of subsurface conditions in the drywells surrounding the tank. Drywell monitoring has been used extensively in the past for LDM. As monitoring drywells are not installed around the C-200-series tanks, this method is not an option. Annulus leak detection will be used in receiver tank AN-106 (RPP-15230).

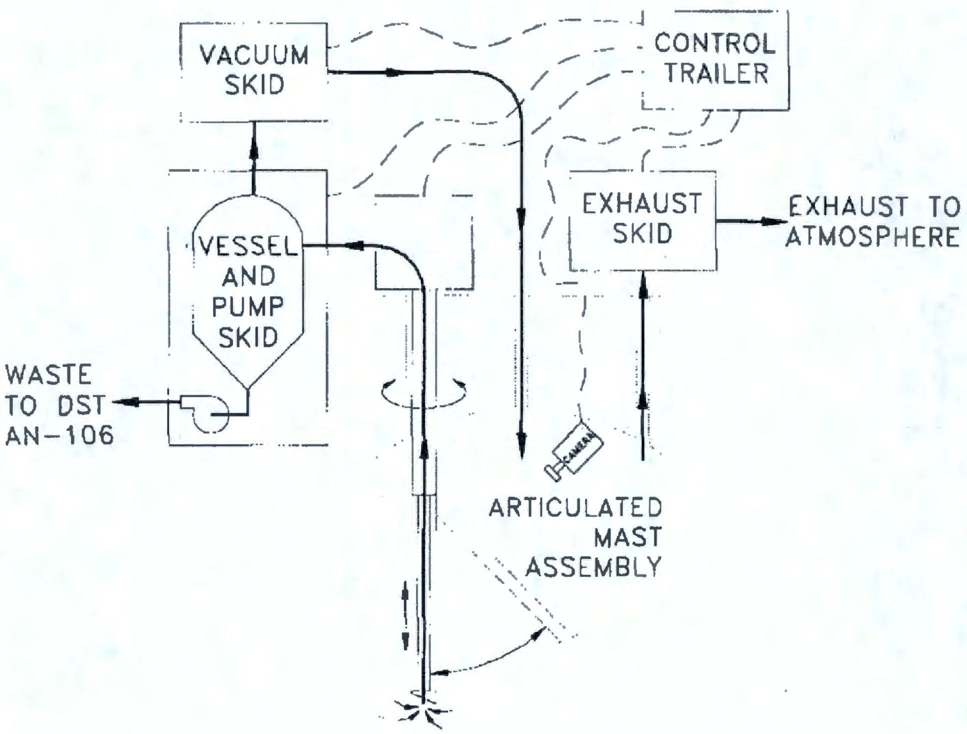
4.2 SYSTEM DESCRIPTION

The waste retrieval and LDM systems described in this section represent an overview of the system currently planned for deployment in the C-200-series tanks. Modifications during fabrication and 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 this document.

4.2.1 Waste Retrieval System Description

The C-200-Series Tanks Project will use a vacuum retrieval system mounted on an articulating mast to remove waste. If needed, a high pressure low volume water jet can be used to dislodge waste so the vacuum can remove it. The waste is deposited in a batch vessel where load cells indicate the waste batch volume. The recovered waste will be mixed and diluted as necessary for transfer through a hose-in-hose assembly to tank AN-106 (Figure 5).

Figure 5. Waste Retrieval System Diagram



The vacuum will be produced by tandem vacuum pumps installed upstream of the waste receiving vessel. Offgas from the vacuum system will be returned to the tank. Active ventilation on the tank, provided by an exhaust system, will filter and monitor the exhaust prior to discharge to the atmosphere.

The system design is intended for multiple deployments and will typically be comprised of skids and modular assemblies including the following:

- Articulated mast assemblies (one each for tanks C-201, C-202, C-203, and C-204)
- Vessel and pump skid
- Vacuum skid
- Vacuum exhaust manifold
- Hydraulic power packs (two total)
- Utility manifold skid
- Exhauster skid
- Slurry diversion box and manifold
- Compressed air skid
- Water supply skid
- Electrical skid.

A possible arrangement for the equipment is shown in Figure 6.

4.2.2 Leak Detection and Monitoring System Description

The C-200-series tanks WRS uses instrumentation to monitor liquids added to and removed from the tank. Figure 3 illustrates the lack of monitoring drywells adjacent to the C-200-series tanks. The absence of drywells around the C-200-series tanks eliminates the ability to deploy moisture monitoring and spectral gamma monitoring techniques for leak detection during waste retrieval.

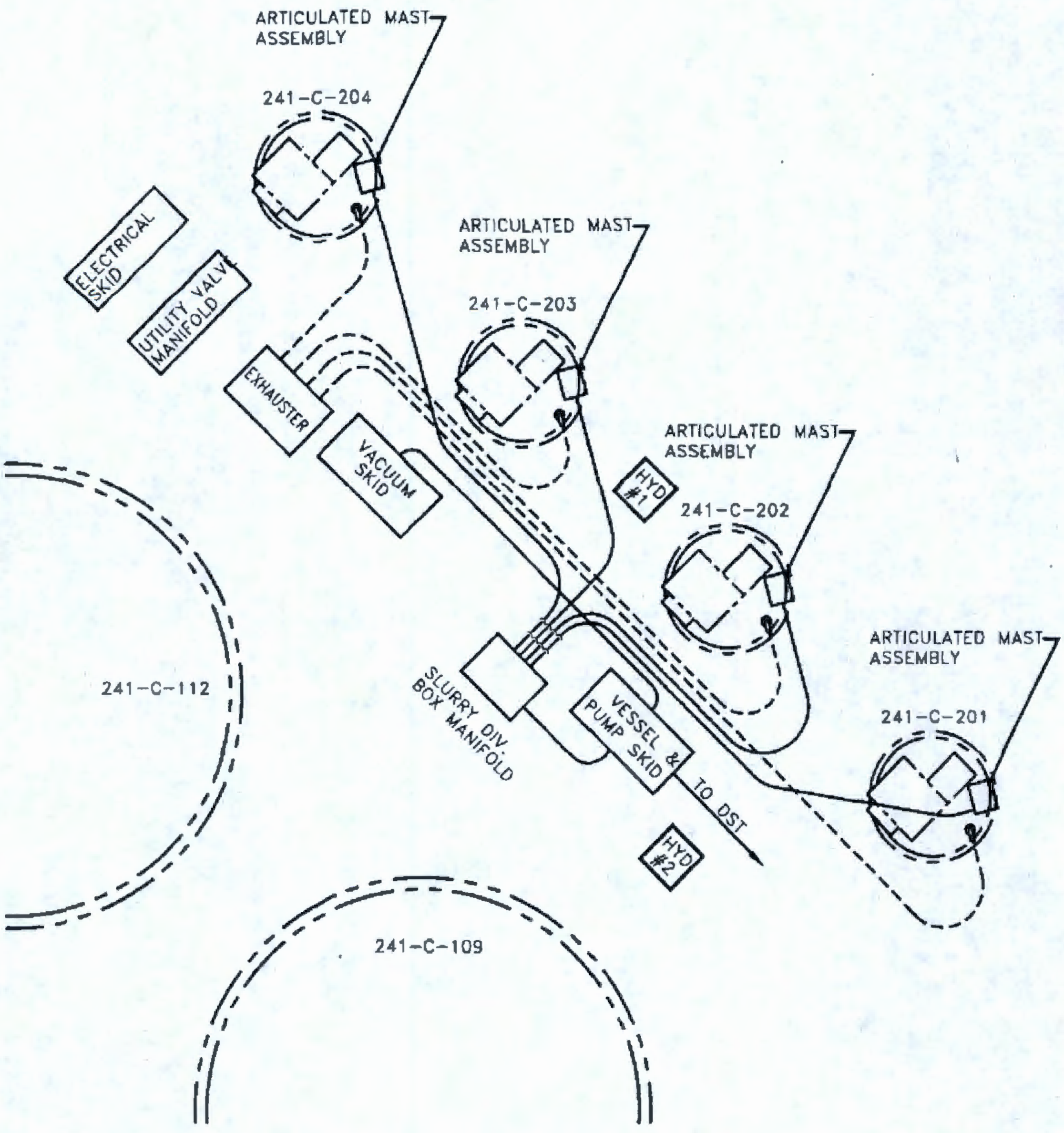
In the absence of available ex-tank methods at the C-200-series tanks, good engineering practice dictates the observation of process control data that could indicate possible liquid loss.
A running total of liquid added to the tank and dilution water added for transfer conditioning will be compared to the liquid fraction of the waste pumped into the transfer line to reveal a gross deficit due to possible leakage. Volumes of liquid added to the tank for retrieval, liquid added to slurry waste in the batch vessel, and total waste slurry volume transferred out will be measured by in-line flow meters.

The baseline LDM methods for receipt tank AN-106 include level monitoring within the tank and conductivity probes and continuous air monitoring in the DST annulus.

4.2.2.1 Ex-Tank Leak Detection

Available ex-tank leak detection methods involve indirect measurement of subsurface conditions in the drywells surrounding the tank. Drywell monitoring has been used extensively in the past for LDM depending on the number and proximity of drywells to the tank of interest. No monitoring drywells are installed around the C-200-series tanks. The installation of new drywells is currently outside the scope of the C-200-Series Tanks Project. For the C-200-series tanks, drywell monitoring techniques are not an option.

Figure 6. C-200-Series Waste Retrieval Site Plan



The vacuum skid emergency drains will be directed to tank C-203.

4.2.2.2 In-Tank Static Liquid Level Monitoring

Due to low volumes of waste in the C-200-series tanks, estimated retrieval duration, and operational approach to minimizing free liquids, a free liquid surface will not be present for any appreciable time and no in-tank static liquid level monitoring is planned in the SSTs.

A direct Enraf™[2] level-sensing instrument will be used in tank AN-106, the receipt tank for waste retrieved from the C-200-series tanks. This instrumentation has a high degree of resolution and repeatability and is well suited for the volumetric method in tanks with a measurable air-liquid interface.

4.2.2.3 In-Tank Dynamic Mass Balance (During Operation)

As good engineering practice, process control data will be used to compare liquid added to liquid removed from the tank. A running total of volume of liquid added to the tank and dilution water added for transfer conditioning will be compared to the liquid fraction of the waste pumped into the transfer line to reveal a gross deficit due to possible leakage.

Static level detection will be used for mass balance calculations in receipt tank AN-106. Flow meters on the vacuum retrieval system transfer piping will provide mass balance input from the C-200-series tanks.

4.2.2.4 Leak Detection in Transfer Lines and Pits

Liquid waste and slurries will be transferred from the C-200-series tanks to tank AN-106 using temporary hose-in-hose over ground transfer lines and existing valve pits. Leak detectors located in slurry manifold and tank AN-106 waste receipt pit will be monitored in the C-200-series waste retrieval control trailer. The WRS will shut down if a leak is detected in the transfer system.

Leakage from the primary over ground transfer hose (inner hose) will be contained by the secondary confinement system (outer hose) and detected by one of the leak detectors. The secondary confinement system has been designed to drain any fluid released from the primary hose to a common point for collection, detection, and removal. Leak detection elements installed in the pits, diversion box, and pump skid actuate an alarm and annunciator light in the control room if a leak is detected and shut down the waste retrieval system.

4.2.2.5 Leak Detection in the Receiver Double-Shell Tank

Tank AN-106 is selected as the receiver DST for waste from the C-200-series tanks. A leak from the primary vessel is detected by either a conductivity probe leak detection system installed in the annulus or a continuous air monitor that detects airborne radionuclides entrained in the annulus ventilation exhaust stream. Detection of a leak into the annulus of the tank by either system activates an audible alarm and an annunciator panel light.

The tank annulus is designed to collect and direct waste that leaks from the primary tank to the annulus for detection and transfer. Slots cut in the insulating concrete that supports the tank at the bottom are designed to drain any leakage to the annulus floor. Conductivity probe

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[2] EnrafTM-Nonius Series 854 is a trademark of Enraf-Nonius, N. V. Verenigde Instrumentenfabrieken Enraf-Nonius CORPORATION NETHERLANDS Rontegenweg 1 Delft NETHERLANDS

assemblies on the annulus floor and a radiation monitor leak detection system on the annulus ventilation system are installed to detect tank leaks.

4.3 OPERATING STRATEGY

The operating strategy for performing LDM and retrieval applies before, during, and after waste retrieval as described below. The strategy is consistent with the current level and maturity of the C-200-series tank WRS design, as well as consistent with the F&Rs established in this document.

4.3.1 Leak Detection and Monitoring Operations

Before initiating waste retrieval operations a visual assessment of in-tank conditions will be performed using the in-tank camera. Additionally, baseline conditions (e.g., volume) within the receipt DST will be established to support mass balance calculations.

During waste retrieval operations, process control data will be collected and dynamic mass balance performed as an indicator of a leak. If a leak is detected during waste retrieval operations, data collection activities will be continued in an effort to monitor leak rates and total leak volumes to the extent possible.

The overall waste retrieval operating strategy will consist of reducing the tank inventory and minimizing liquid additions during waste retrieval operations. Process control parameters will be monitored to track liquid inventories while waste is actively being retrieved. The strategy for leak detection at tank AN-106 involves static level monitoring for gross mass balance to assess transfer line integrity and utilizing DST annulus leak detection systems. This approach represents deployment of the best available technology in these tanks.

4.3.2 Leak Mitigation Operations

If a leak is detected at a C-200-series tank during waste retrieval operations, the leak volume will be estimated using process control data. At tank AN-106, static level monitoring will be used to assess potential leak volume.

If a leak is indicated during waste retrieval operations, process control 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 start up and continue under normal operating procedures. However, if a leak is validated, the operating contractor will notify the Office of River Protection, which will in turn notify Ecology. The process control procedures will consider the leak loss limit, leak loss rate, and estimated duration to completion of waste retrieval operations when determining the appropriate response action. Potential response actions include the following:

- Modify leak monitoring (e.g., implementing more frequent in-tank mass balance)
- Modify waste retrieval operating conditions
- Discontinue adding liquids
- Stop all 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. The requirements for implementation of leak response actions during waste retrieval operations will be established in the process control plan that will be developed concurrent with the design of the waste retrieval and LDM system.

4.3.3 Waste Retrieval Operations

The overall waste retrieval operating strategy will consist of reducing the tank waste inventory and minimizing liquid additions during waste retrieval operations. The process will be monitored using closed-circuit television to facilitate waste retrieval and minimize any liquids in the tank. Water will be used in limited quantities as necessary for waste conveyance and transfer line flushing.

During normal operations, the composite rate of removal from the tank on average will exceed the rate of water introduction. The composite material removed will consist of both mobilized tank waste and water used to affect mobilization. Maintaining a higher pumping rate out of the tank is integral to minimizing the liquid that escapes from the area immediately local to the vacuum suction inlet. The increased leak potential associated with the addition of water will be minimized by maintaining a vacuum rate higher than the water introduction rate.

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