SRR-CWDA-2017-00015

Revision 1

Consolidated General Closure Plan
for
F-Area and H-Area Waste Tank Systems

April 2017

Prepared by: Savannah River Remediation LLC
Waste Disposal Authority
Aiken, SC 29808

Prepared for U.S. Department of Energy Under Contract No. DE-AC09-09SR22505

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REVISION SUMMARY

REV. #	DESCRIPTION	DATE OF ISSUE
0	Initial submittal	March 1, 2017
1	Tables 11.2-1 and 11.2-2 were revised to address comments from the U.S. Department of Energy and South Carolina Department of Health and Environmental Control. Figures 5.3-1 and 5.3-2 were also slightly modified to match the table changes. Attachment 1, the *SRS Waste Removal Plan and Schedule for F-Area and H-Area Waste Tank Systems* SRR-CWDA-2017-00014, was updated to Revision 1 and replaced. Minor editorial corrections were also incorporated.	April 2017

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LIST OF ACRONYMS

ADMP	Advanced Design Mixer Pump
ALARA	As Low As Reasonably Achievable
AOC	Areas of Concern
ARP	Actinide Removal Process
ASR/MD	Add, Sit, Remove/Molecular Diffusion
BOAC	Bulk Oxalic Acid Cleaning
CA/RA	Corrective Action/Remedial Action
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CGCP	Consolidated General Closure Plan
CM	Closure Module
CMCOCs	Contaminant Migration Constituents of Concern
COC	Chemicals of Concern
CSMP	Commercial Submersible Mixing Pump
CSR	Chemical Sludge Removal
CSSX	Caustic-Side Solvent Extraction
CTS	Concentrate Transfer System
DASR	Drain, Add, Sit, Remove
DB	Diversion Box
DCF	Dose Conversion Factor
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
DWPF	Defense Waste Processing Facility
ECR	Effective Cleaning Radius
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Difference
ETP	Effluent Treatment Project
FCR	Final Configuration Report
FFA	Federal Facility Agreement
FMB	Fourmile Branch
FTF	F-Area Tank Farm
GSA	General Services Area
HEPA	High-Efficiency Particulate Air
HTF	H-Area Tank Farm
IASB/PP	Interim Action Statement of Basis/Proposed Plan
ICM	Integrated Conceptual Model
ICMI/RAIP	Interim Corrective Measures Implementation/Remedial Action Implementation Plan
IROD	Interim Record of Decision
ITP	Interim Treatment Process
LDB	Leak Detection Box
LTAD	Low Temperature Aluminum Dissolution
LWTRSAPP	Liquid Waste Tank Residuals Sampling and Analysis Program Plan
LWTRS-QAPP	Liquid Waste Tank Residuals Sampling – Quality Assurance Program Plan

MCL	Maximum Contaminant Level
MCU	Modular Caustic Side Solvent Extraction Unit
MDC	Minimum Detectable Concentration
MDG	Modified Density Gradient
MFB	Mechanical Feed and Bleed
MLDB	Modified Leak Detection Box
MOP	Member of the Public
MSR	Mechanical Sludge Removal
MST	Monosodium Titanate
OA	Oxalic Acid
OU	Operable Unit
PA	Performance Assessment
PCA	Pollution Control Act
PP	Pump Pit
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD/CM	Remedial Design/Corrective Measure
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RFS	Removal From Service
ROD	Record of Decision
RSL	Regional Screening Level
SA	Special Analysis
SCD	Semi-Continuous Dissolution
SCDHEC	South Carolina Department of Health and Environmental Control
SDF	Saltstone Disposal Facility
SLP	Slurry Pump
SMP	Submersible Mixer Pump
SPF	Saltstone Production Facility
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
STP	Submersible Transfer Pump
SWMU	Solid Waste Management Unit
SWPF	Salt Waste Processing Facility
TCCR	Tank Closure Cesium Removal
TDL	Target Detection Limit
TEDE	Total Effective Dose Equivalent
TNX	Training and Experimental Test Facility
TSAP	Tank-Specific Sampling and Analysis Plan
UCL95	Upper 95% Confidence Limit
UTR	Upper Three Runs
VFD	Variable Frequency Drive
WCS	Waste Characterization System
WOW	Waste on Wheels
WTS	Waste Transfer System

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EXECUTIVE SUMMARY

This Consolidated General Closure Plan for F-Area and H-Area Waste Tank Systems (CGCP) has been prepared to support the future removal from service of the F-Area Tank Farm (FTF) and H-Area Tank Farm (HTF) underground radioactive waste tanks and the ancillary structures present at the Savannah River Site (SRS) that are regulated under the *F and H Area High Level Radioactive Waste Tank Farms Construction Permit No. 17424-IW* (hereinafter referred to as Construction Permit #17,424-IW), and the SRS Federal Facility Agreement (FFA) which will control the subsequent remediation of FTF and HTF. [DHEC_01-25-1993, WSRC-OS-94-42] This CGCP does not apply to other industrial wastewater regulated facilities that are within the footprint of the HTF, but constructed and operated under separate permits. Closure plans for those facilities will be submitted separately. There are no other industrial wastewater regulated facilities within the FTF. This CGCP is not applicable to underground radioactive waste Tanks 5F, 6F, 17F-20F, 16H, and 12H that have already been removed from service under previously approved closure plans.

The SRS is one of the facilities in the U.S. Department of Energy (DOE) complex constructed to produce nuclear materials. Since beginning operations in the early 1950s, uranium and plutonium recovery processes have generated liquid radioactive waste, which is currently stored in underground tanks in the F and H Areas at the site. The DOE intends to remove from service the waste tanks, giving priority to those that do not meet the standards established in Appendix B of the SRS FFA, which was entered into pursuant to Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Sections 3008(h) and 6001 of the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (hereinafter jointly referred to as RCRA) and the Atomic Energy Act of 1954, as amended, 42 U.S.C. § 2011[1]. [WSRC-OS-94-42] Removal of these tanks from service will reduce the risk of a leak to the environment and provide a stable form that is protective of human health and environment.

Although the waste tank system removal effort intends to remove or decontaminate all residues, contaminated containment system components (liners, etc.), and structures and equipment contaminated with hazardous and/or radioactive substances to the extent practicable from an engineering perspective, it is recognized that DOE cannot practicably remove or decontaminate all structures and equipment. Therefore, after the South Carolina Department of Health and Environmental Control (SCDHEC), U.S. Environmental Protection Agency (EPA), and DOE mutually agree that waste removal may cease, any residual contaminants will be stabilized and the waste tanks shall be removed from service in accordance with the Pollution Control Act (PCA), S.C. Code Ann., Section 48-1-10, et seq. (1985) and all applicable regulations promulgated pursuant to the PCA. Applicable regulations include SCDHEC R.61-67, *Standards for Wastewater Facility Construction* and SCDHEC R.61-82, *Proper Closeout of Wastewater Treatment Facilities*. Removal from service includes operational closure of the waste tank system under, and then removal from, the Construction Permit #17,424-IW and the SRS FFA which will control the subsequent remediation of the FTF and HTF. The terms "operational

[1] DOE's submittal of this plan does not waive any DOE claim of jurisdiction over matters reserved to it under the Atomic Energy Act of 1954.

closure" and "removal from service" are considered synonymous. [DHEC_01-25-1993, WSRC-OS-94-42]

The DOE has identified environmental requirements and guidance considered pertinent to the F- and H-Area waste tank systems' removal from service and has derived performance objectives to be met for the protection of human health and the environment, and to provide information for use in a potential RCRA/CERCLA response action in FTF and HTF after all waste tanks and ancillary structures have been removed from service. The performance objectives used are the SCDHEC R.61-58, *State Primary Drinking Water Regulations* for radionuclides and the SCDHEC maximum contaminant levels (MCLs) for non-radiological constituents. An FTF Performance Assessment (FTF PA) and an HTF Performance Assessment (HTF PA) have been developed to assess the long-term fate and transport of any residual material in the waste tanks and ancillary equipment, and to provide reasonable assurance that groundwater concentrations derived from residual material in the waste tanks and ancillary structures will be within those performance objectives. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

The DOE will prepare detailed waste tank-specific closure modules (CMs), which will be submitted to SCDHEC and EPA for review. Each CM will provide details of any residual contamination content based on sampling and analysis and/or process knowledge. After SCDHEC approves the CM and EPA concurs, all agencies are in agreement that waste removal activities can cease and DOE will stabilize the residual contaminants as the final step of the SCDHEC approved removal from service of each waste tank and associated ancillary structures. Following stabilization of each group of waste tanks or waste tank system, DOE will submit a final configuration report to SCDHEC with certification that the closure activities have been performed in accordance with the CGCP and the CM. Each CM will represent an incremental removal from service related to Construction Permit #17,424-IW.

1.0 INTRODUCTION

Since the early 1950s, the primary mission of SRS had been to produce nuclear materials for national defense and deep space missions. The processes used to recover these nuclear materials from production reactor fuel and target assemblies in the chemical separations areas at SRS generated significant volumes of liquid radioactive waste. This waste is currently stored in F and H Areas near the center of the site. Today, the primary focus at SRS is environmental restoration with the highest priority being removal, treatment, and disposal of the liquid waste in the FTF and HTF.

In support of environmental restoration activities at SRS, DOE, EPA, and SCDHEC signed a FFA pursuant to Section 120 of CERCLA and Sections 3008(h) and 6001 of RCRA. The agreement became effective in August 1993. As part of this comprehensive agreement, DOE has committed to remove from service those liquid radioactive waste tank systems that do not meet the standards set forth in Appendix B of the FFA. Appendix B of the FFA also defines the specific waste tank systems that are subject to the agreement. [WSRC-OS-94-42]

The FFA identifies the approved plan and schedule for this work. [WSRC-OS-94-42] This CGCP incorporates the current, approved plan by reference and as the *SRS Waste Removal Plan and Schedule for F-Area and H-Area Waste Tank Systems* (SRR-CWDA-2017-00014) in Attachment 1. Should the schedule be amended pursuant to the process set forth in the FFA, with the agreement of SCDHEC (agreement not to be unreasonably withheld), DOE will provide a revised version of the waste removal plan and schedule document (Attachment 1) to SCDHEC and it will be considered a modification to the CGCP. When the CGCP is revised the current revision of the waste removal plan and schedule document will be included. Because revisions and issuance of the waste removal plan and schedule document and CGCP will necessarily lag behind future FFA schedule amendments, the latest revision of the FFA Appendix L should be consulted for the most current schedule.

The Industrial Wastewater Construction Permit #17,424-IW addresses the F-Area and H-Area Tank Farms. Due to past releases, Tank 16H was not originally included in Construction Permit #17,421-IW but was added on November 23, 2010 to facilitate waste removal efforts in support of this waste tank being removed from service under the approved waste removal and operational closure schedule in the FFA. [SRR-CES-2010-00067, DHEC_11-23-2010] On December 3, 1999, the 242-25H evaporator system was added to Construction Permit #17,424-IW. [DHEC_12-03-1999] Tank 50H was originally permitted under Construction Permit #14,520-IW but was subsequently added to Construction Permit #17,424-IW on August 17, 2001. [DHEC_08-17-2001]

This CGCP does not apply to other industrial wastewater regulated facilities that are within the footprint of the HTF, but constructed and operated under separate permits. The Actinide Removal Process (ARP) in Building 241-96H was constructed under Construction Permit #19,169-IW. [DHEC_01-15-2008] The portion of ARP treatment in Building 512-S is authorized under Construction Permit #18,793-IW. [DHEC_04-08-2003] The Modular Caustic Side Solvent Extraction Unit (MCU) was constructed under Construction Permits #19,037-IW, MCU Phase 1 (DHEC_03-29-2006) and #19,094-IW, MCU Phase 2 (DHEC_02-01-2007). ARP/MCU has been authorized to operate until four to six months prior to Salt Waste Processing

Facility (SWPF) operations. [DHEC_02-22-2011] Closure plans for these facilities will be submitted separately. There are no other industrial wastewater regulated facilities within the FTF other than those covered by Construction Permit #17,424-IW. This CGCP is not applicable to underground radioactive waste Tanks 5F, 6F, 17F-20F, 16H, and 12H that have already been removed from service under previously approved closure plans.

After wastes are removed from individual waste tank systems and the systems are stabilized, the waste tank systems will be removed from service under, and then removed from, the industrial wastewater permit that regulates their operation. SCDHEC will regulate the waste tank system removals from service via Construction Permit #17,424-IW, applicable South Carolina law and regulation, and the SRS FFA. [DHEC_01-25-1993, WSRC-OS-94-42] This CGCP describes the process by which DOE will document the future removal from service of individual waste tank systems in FTF and HTF. This CGCP compiles relevant information contained in the closure related documents identified in Tables 1.0-1 and 1.0-2.

Table 1.0-1: Superseded General Closure Plans

Document Number	Title	Date Issued	Applicable to Closed Tanks
PIT-MISC-0006 Rev. 1	Industrial Wastewater General Closure Plan for F- And H-Area High-Level Waste Tank Systems	July 1996	17F and 20F
LWO-RIP-2009-00009 Rev. 3	Industrial Wastewater General Closure Plan for F-Area Waste Tank Systems	January 2011	5F, 6F, 18F, and 19F
SRR-CWDA-2011-00022 Rev. 0	Industrial Wastewater General Closure Plan for H-Area Waste Tank Systems	May 2012	12H and 16H

Table 1.0-2: Closure Modules for Waste Tanks Already Removed From Service

Document Number	Title	Date Issued
PIT-MISC-0002 Rev.1	Industrial Wastewater Closure Module for the High-Level Waste Tank 20	January 1997
PIT-MISC-0004 Rev. 2	Industrial Wastewater Closure Module for the High-Level Waste Tank 17	August 1997
SRR-CWDA-2010-00003 Rev. 2	Industrial Wastewater Closure Module for the Liquid Waste Tanks 18 and 19 F-Area Tank Farm, Savannah River Site	January 2012
SRR-CWDA-2012-00071 Rev. 1	Industrial Wastewater Closure Module for the Liquid Waste Tanks 5F and 6F F-Area Tank Farm, Savannah River Site	April 2013
SRR-CWDA-2013-00091 Rev. 1	Industrial Wastewater Closure Module for Liquid Waste Tank 16H H-Area Tank Farm, Savannah River Site	April 2015
SRR-CWDA-2014-00086 Rev. 0 and SRR-CDWA-2015-00074 Rev. 0	Industrial Wastewater Closure Module for Liquid Waste Tank 12H H-Area Tank Farm, Savannah River Site and Addendum to the Industrial Wastewater Closure Module for Liquid Waste Tank 12H H-Area Tank Farm, Savannah River Site	May 2015 and October 2015

1.1 Purpose and Objectives

The purpose of this CGCP is to set forth the general protocol by which DOE intends to remove from service the waste tanks and ancillary structures at the FTF and HTF to protect human health and the environment in accordance with SCDHEC R.61-82, *Proper Closeout of Wastewater Treatment Facilities*, and R.61-67, *Standards for Wastewater Facility Construction*. [SCDHEC R.61-82, SCDHEC R.61-67] For the purposes of this document, FTF and HTF include the radioactive waste tank systems located in F-Area and H-Area, respectively, as described in Appendix B of the FFA. The term "waste tank system" is intended to include individual waste tanks or group of waste tanks and associated ancillary structures used to support operations. This CGCP implements the applicable environmental regulatory standards and guidelines pertinent to removal from service of the waste tank systems and describes the process for evaluating the stabilized waste tank system configuration. This CGCP also describes the method of stabilizing the waste tank systems and residual contamination associated with these systems. Additionally, this CGCP describes the integration of the waste tank system closure activities with existing commitments to remove waste from the waste tank systems before removal from service, and ultimately to investigate, assess, and to take appropriate response action (if needed) concerning the FTF and HTF under the FFA.

The specific objectives of this CGCP are as follows:

- Identify the state environmental requirements and guidance that apply to the removal from service of FTF and HTF individual waste tank systems, and describe how DOE will comply with these requirements.
- Describe the process DOE will follow in selecting waste removal and stabilization methods for individual waste tank systems as they are removed from service.
- Describe the process for characterization and quantification of residuals remaining in the waste tank systems following waste removal activities.
- Describe the methodology for determining impacts of individual removal actions such that the final closure of all FTF and HTF systems will comply with environmental standards.
- Describe the specific documentation that will be required to detail waste removal activities, stabilization and facility status and the process that will be used to review and approve this documentation and authorize removal from service.
- Describe the maintenance and monitoring of closed tanks during the interim period until final closure of the FTF Operable Unit (OU) and HTF OU.
- Provide facility descriptions of each tank farm and types of tanks.

The process outlined in this CGCP is intended to comply with the requirements of SCDHEC R.61-82 and R.61-67 and be consistent with the requirements of the FFA, under which both FTF and HTF will eventually be assessed for any appropriate response action. This document is not intended to satisfy or to replace the requirements of the DOE Manual 435.1-1, *Tier 1 Closure Plan for the F-Area Waste Tank Systems at the Savannah River Site* (SRR-CWDA-2010-00147), *Tier 1 Closure Plan for the H-Area Waste Tank Systems at the Savannah River Site* (SRR-CWDA-2014-00040) or Tier 2 Closure Plans. This CGCP will not be updated on a standard, predetermined schedule but, instead, will be revised when either DOE or SCDHEC believes the process described in this document needs to be updated.

1.2 F-Area and H-Area Waste Tank Systems Consolidated General Closure Plan Structure

Section 1: Introduction – describes previous closure plan histories and the CGCP purpose, objectives, and structure.

Section 2: Stabilization and Isolation – describes the stabilization and isolation processes for the waste tank systems.

Section 3: Maintenance and Monitoring – describes the maintenance and monitoring plans for the interim period from the time the waste tank system is removed from service until the final closure of FTF and HTF OUs.

Section 4: Waste Tank Descriptions – provides a description of the types of liquid radioactive waste tanks. A detailed description can be found in each tank farm's PA that has been prepared to provide the input to this document and to other regulatory documents required for closure activities in either FTF or HTF. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Section 5: Facility Descriptions – provides a description of the tank farms and ancillary structures included in the FTF and HTF. A detailed description can be found in each tank farm's PA that has been prepared to provide the input to this document and to other regulatory documents required for closure activities in either FTF or HTF. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Section 6: Waste Removal Methodology – describes the process for selecting waste removal technologies appropriate to the waste tank system and determining the appropriate extent of removal activities. Although removal of the bulk waste from an individual waste tank or from associated ancillary structures is an operational activity (i.e., not specifically part of waste tank system closure), it is an essential precursor to waste tank removal from service.

Section 7: Waste Removal Technology and Deployment – describes the mechanical and chemical processes used to remove waste from tanks.

Section 8: Waste Characterization – describes the methodology for characterizing the residual waste remaining in the tank after waste removal activities have ceased.

Section 9: Performance Evaluation – identifies the performance objectives applicable to removal from service of the waste tank systems and describes the methodology for using fate and transport modeling to assess the long-term impact of any residual contamination. Although high-level summary results from the FTF and HTF PAs are presented here, the specific details of the modeling and associated results are provided in the FTF and HTF PA documents.

Section 10: Regulatory Framework – identifies the applicable regulatory framework to remove the waste tank systems from service.

Section 11: Closure Module Preparation and Approval – describes the process that will be used to develop, review, and approve the CM for individual waste tank systems and ultimately to receive approval to remove the waste tank system from the governance of Construction Permit #17,424-IW. The anticipated durations for some activities in this process are also presented.

2.0 STABILIZATION AND ISOLATION

In May 2002, DOE issued an Environmental Impact Statement (EIS) on waste tank cleaning and stabilization alternatives. [DOE/EIS-0303] The DOE studied five alternatives, 1) empty, clean and fill with grout, 2) empty, clean and fill waste tank with sand, 3) empty, clean and fill waste tank with saltstone, 4) clean and remove waste tanks, and 5) no action.

Evaluations described in the EIS showed the "Empty, clean and fill with grout" alternative to be the best approach to minimize human health and safety risks associated with closure of the waste tanks. [DOE/EIS-0303]

Filling a cleaned waste tank with grout provides stability to the walls and ceiling. The grout fill also helps to reduce water intrusion into the waste tank over time. Reducing the amount of water allowed to enter a closed waste tank retards the migration of residual material from the waste tank to the environment. The DOE issued a Record of Decision (ROD) selecting the "Empty, clean and fill with grout" alternative for SRS waste tank closure in August 2002. [DOE/EIS-0303 ROD]

Each of the waste tank systems has a unique operating history, as well as various hydrogeologic characteristics, such as the distance from the water table and the distance to nearby streams. The DOE will determine the removal from service configuration for each waste tank system on a case-by-case basis, although all removal from service actions will have common features. Common features include: 1) final isolation by eliminating mechanical and electrical services and removing or isolating accessible piping and conduits and, 2) ensuring the long-term stability of the structure or equipment which includes filling with grout. Prior to filling a waste tank with grout, the tank must be isolated from the waste transfer system and chemical addition systems and any other service that may increase a tank's final inventory. Other services (e.g., ventilation, electrical, air, etc.) may be left operational during grouting of the tank to aid in As Low As Reasonably Achievable (ALARA) practices. The waste tank will be completely isolated from any remaining tank farm services after waste tank grouting is finished. Failed equipment, or equipment that is no longer needed, may be encapsulated in the fill material when removing a waste tank system from service. This equipment may be associated with the waste tank that is undergoing removal from service or another waste tank system that is undergoing removal from service in FTF or HTF. The CM for the waste tank system(s) will provide details of the all of the equipment and structures that will remain in a waste tank system.

A Grout Strategy document will be developed for grouting an individual waste tank. This document will identify the specification for the bulk-fill grout to be used for the waste tank primary and annulus as well as the specifications for high-flow grout, cooling coil grout, and equipment fill grout if needed. The bulk-fill grout material is formulated to be flowable, pumpable, and self-leveling with cohesive properties to minimize segregation and facilitate grout placement to support waste tank system removal from service. To ensure the waste tanks are grouted to the extent practicable (i.e., to minimize potential void space), alternate grout formulas may be needed at times during the grouting process for an individual waste tank. This will allow DOE to take advantage of the different flow characteristics of various grout specifications. However, the use of alternate grout formulas for the bulk-fill, cooling coil, and/or the equipment fill grout represents a change to the grout strategy for an individual tank. This situation will require an evaluation against applicable operational and performance documents to determine if it is acceptable from programmatic, technical, and safety considerations to use the alternate grout. If the evaluation determines that it is acceptable to use the alternate grout, the change will be provided to SCDHEC for their review and approval prior to using the alternate grout. SCDHEC will be approving the use of the alternate grout not the procurement specification for the alternate grout.

It is anticipated that grout material compositions and technologies will be improved during the course of removal of FTF and HTF waste tanks from service. The DOE plans to take advantage of improvements, as appropriate, and to discuss them in subsequent grout strategy documents for other waste tank systems. Note, that if different grout formulas are chosen for grouting an individual waste tank, these changes will be determined and evaluated against applicable operational and performance documents. If the evaluation determines that it is acceptable to use the alternate grout, the change will be provided to SCDHEC for their review and approval prior to using the alternate grout. SCDHEC will be approving the use of the alternate grout not the procurement specification for the alternate grout.

This removal from service configuration for each waste tank system will promote long-term stability of the system. Those components of the systems where fill material will be utilized will reduce the migration of residuals remaining, fill voids to the extent practicable, and prevent future subsidence of the structures. In addition, the configuration discourages inadvertent intrusion. Additional information on the waste tank system stabilization can be found in Section 3.2.3 of the respective FTF or HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128] This configuration is the current baseline case in both the FTF and HTF PAs. Alternative configurations may be evaluated in the future and, if found to be suitable, may be implemented with approval of SCDHEC.

Ancillary structures associated with each waste tank system may be filled contingent on the specific characteristics of that structure and will be fully documented in the applicable CM.

The following sections summarize the planned waste tank system isolation process and subsequent stabilization strategy to be implemented on a tank after waste removal is complete. In particular, the following attributes will be described:

- Waste tank system isolation process and system final configuration.
- Description of structures and equipment that are part of this removal from service (RFS) activity including any equipment that will remain in a tank at the time of RFS.
- Stabilization strategy including type and characteristics of the fill material (i.e., grout) as appropriate.

Stabilization options will continue to be evaluated throughout the FTF and the HTF removal from service process.

2.1 Waste Tank System Isolation Process

The isolation process for a tank separates the waste tank from the associated tank farm's Waste Transfer System (WTS), Chemical Addition System, and support systems. The WTS and Chemical Addition System isolation will occur prior to grout addition. To reduce redundancy and improve closure efficiency, an individual waste tank, or group of waste tanks, may be partially isolated by disconnecting the other support systems at strategic times either before, during, or after the grouting process. Partial isolation will eliminate the waste tanks' ability to operate, but will allow the use of systems such as tank ventilation that are needed during the grouting process. The DOE will ensure complete isolation from support systems prior to requesting waste tank removal from Construction Permit #17,424-IW. Isolation approach details for each waste tank will be presented in the associated CM. Implementation of the process consists of identification and isolation of the following:

- Material (waste and chemical) transfer and addition lines,
- Piping associated with the facilities water, air, and steam systems,
- Electrical cables used to supply equipment, instrumentation, and control and monitoring capabilities,
- Penetrations into, or out of, the waste tank.

Isolation for mechanical systems will be at the system supply headers located away from the tank top where practical, although system configuration may require isolation to occur at the tank top but outside of the primary tank. Isolation of power and instrumentation signal distribution will occur at the safest location between the tank top equipment and power or signal source locations (e.g., control rooms, motor control centers, etc.). Where practical, accessible piping and conduit will be removed creating a physical break from the waste tank. Other pipes will be plugged or capped to isolate them from the FTF and HTF systems. Isolating all waste tank systems will render the tank closed to waste processing activities. Waste tank system and ancillary structure removals from service will be tracked as described in Section 11.

As a waste tank is filled with grout, the grout material will flow into the isolated waste tank, risers, and waste tank penetrations, thereby effectively sealing the abandoned transfer lines. This will eliminate the possibility of transferring waste into, or out of, the waste tank through the transfer lines. Though the grout will seal the transfer lines at the waste tank penetrations, there are no current plans to fill the abandoned transfer lines exterior to a waste tank with grout. The waste transfer lines were modeled with no grout in the both the FTF and HTF PAs and the results predicted compliance with the required performance objectives. [SRS-REG-2007-00002, SRR-CWDA-2010-00128] Because any residual waste would be on the interior wall of the transfer lines and grouting would not significantly influence the leaching rate, there is no environmental benefit to grouting these small diameter transfer lines. In addition, there is no long-term subsidence issue requiring stabilization of the lines due to the small diameter of the transfer piping. Additional details on the isolation plans for a specific waste tank system from its associated WTS and other support systems will be in the respective tank's Isolation Strategy document. As new information is made available from field walkdowns and waste tank inspections, necessary changes will be documented.

2.2 Structure and Equipment Removal From Service

Modifications to the top of each waste tank will be made to accommodate tank grouting and riser capping activities. Risers or other waste tank penetrations, including ventilation systems, extending above the grade level will not require capping if the grout level in the riser or penetration also extends above the grade level. In those risers or waste tank penetrations where bringing the grout level above the grade level is not achievable, a grout cap shall be placed greater than, or equal to, the level of the riser opening.

After external motors, piping, electrical, and instrumentation commodities have been removed from the risers, individual risers may be sealed with bulk-fill grout, high-flow grout, or other suitable material. Each waste tank riser will be filled with grout from the top. After all waste tanks and ancillary structures in FTF and HTF have been removed from service, decisions on removal of external structures such as structural steel trusses, mechanical and electrical piping/conduit, instrumentation and power cables/wiring, raceways, motors, and any other remaining equipment on the waste tank top footprint will be addressed in conjunction with the final RCRA/CERCLA closure of the FTF and the HTF OUs.

Additional details on the isolation from service of the waste tank mechanical and electrical equipment and piping systems will be presented in the waste tank's Isolation Strategy document. The isolation strategy for each tank will be updated, as necessary, with new information made available from field walkdowns and tank inspections.

Pieces of equipment used to support a tank's waste removal efforts and heel removal efforts may be entombed in place as part of the RFS process. A listing of equipment in the tank's primary liner and annulus planned to be entombed in the grout will be included in the tank specific CM. As new information is made available from field walkdowns and tank inspections, any necessary changes will be documented. Internal space in this equipment will be filled with grout to the extent practicable to minimize void space, as the waste tank is filled.

2.3 Stabilization Strategy

2.3.1 Waste Tank Grouting Selection

In May 2002, DOE issued an EIS on waste tank cleaning and stabilization alternatives. [DOE/EIS-0303] The DOE studied five alternatives:

1. Empty, clean and fill waste tank with grout
2. Empty, clean and fill waste tank with sand
3. Empty, clean and fill waste tank with saltstone
4. Clean and remove waste tanks
5. No action

The EIS concluded the Fill-with-Grout option was preferred. The DOE also issued a ROD selecting the Fill-with-Grout alternative for SRS waste tank closure. [DOE/EIS-0303] Two subsequent Supplement Analysis reviewed the cleaning methods for FTF and HTF, compared the results to the FTF and HTF PAs, and the 2002 EIS model. Each Supplement Analysis concluded that the new information did not change the 2002 EIS decision to stabilize the tanks and associated equipment by filling with grout. [DOE/EIS-0303-SA-01, DOE/EIS-0303-SA-02]

Evaluations described in the EIS showed the Fill-with-Grout alternative was the best approach to minimize human health and safety risks associated with closure of the waste tanks. [DOE/EIS-0303] This alternative offers several advantages over the other alternatives evaluated such as:

- Provides greater long-term stability of the waste tanks and their stabilized contaminants than the sand-fill approach;

- Provides for retaining radionuclides within the waste tanks by using reducing agents in the grout in a fashion that the sand-fill would not;
- Avoids the technical complexities and additional worker radiation exposure that the fill-with-saltstone approach would entail;
- Produces smaller impacts due to radiological contaminant transport than the sand- and saltstone-fill alternatives;
- Avoids the excessive personnel radiation exposure and provides greater occupational safety impact than would be associated with the clean-and-remove alternative. [DOE/EIS-0303]

Cementitious materials are one of the most commonly used materials for solidifying and stabilizing radioactive wastes, and the technology is at a mature stage of development. [ISBN: 0-309-59313-1] The purpose of this stabilization is to maintain waste tank structure and minimize water infiltration over an extended period of time, thereby impeding the release of stabilized contaminants into the environment. The grout fill that will be used has reducing properties (i.e., low redox or Eh) which minimize the mobility of the chemicals after closure. All grout formulas are alkaline because grout is a cement-based material that naturally has a high pH. This alkalinity is compatible with the carbon steel waste tank construction materials. Grout has a high compressive strength and low permeability, which enhances its ability to limit the migration of contaminants after closure. Testing has demonstrated that the chemical and physical characteristics of the grout formula used at SRS retards the movement of chemical and radiological constituents. [WSRC-TR-97-0102] The grout formulas are also designed to promote flowability, thereby enabling a near level placement within the waste tank. [SRNL-STI-2011-00551, SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Grout is primarily a mixture of cement and water proportioned to produce a pourable consistency. Studies have focused on improving grout production and batching, grout flow, measurement of the effective diffusion coefficients in reducing fill grout, and measurement of hydraulic properties. [WSRC-STI-2007-00369, WSRC-STI-2007-00641]

2.3.2 Waste Tank Grouting Plan

Grout may be supplied by an off-site vendor or an on-site facility that may be constructed in the future. The off-site vendor supplied grout will be delivered to FTF and HTF using unmodified concrete mixer trucks and off-loaded to a hopper where pumps will push the grout through commercially-available slicklines to the primary tank and annulus risers in use at that time for grouting. Alternately, concrete pumper trucks may be used to pump the grout through their mast and boom assemblies to the risers in use for grouting. The slicklines and/or pumper truck piping will be configured to support the filling of one primary or annulus riser at a time. The primary liner and the annulus will be alternately filled with grout in a sequence that will be protective of the waste tank structure.

Reducing grout will be used to fill the entire tank primary and annulus tank volume. The ability of the grout to flow over and around internal tank obstructions and cover the remaining residual material was first successfully demonstrated during the grouting of Tanks 5F and 6F. However, internal waste tank obstructions and interferences in certain waste tanks may increase the risk of uneven grout distribution. To reduce this risk, grout may be introduced into the primary tank at multiple risers or the DOE may choose to use an acceptable alternate grout with greater flowability. As mentioned earlier, prior to alternate grout use, the change will be provided to SCDHEC for their review and comment. SCDHEC will be approving the use of the alternate grout and not the procurement specification for the alternate grout. If additional pour locations are required to cover remaining residual materials, additional access points will be identified and installed to address the exact area requiring special effort. The location and number of risers used during grouting will be dependent on actual field conditions experienced.

Tank grout typically consists of two major states, cured and fresh. The major properties of cured grout include: low effective diffusion coefficient, low hydraulic conductivity, low porosity, high dry bulk density, and a compressive strength sufficient to meet the 2,000 psi HTF PA mixture design or, if less than 2,000 psi, by a compressive strength design value established by an approved evaluation. If the evaluation determines that it is acceptable to use the alternate grout, the change will be provided to SCDHEC for their review and approval prior to using the alternate grout. SCDHEC will be approving the use of the alternate grout and not the procurement specification for the alternate grout. The fresh grout properties include: high flow, low bleed water generation, low air content, high wet unit weight (density), and a set time long enough not to impact the grout mixing, transport, and placement. Slump-flow is used as an acceptance criterion for grout delivered to the tank farms and air content will be measured for information. Quality control requirements of the grout production are included as part of the grout procurement specification.

Independent testing determined that certain formulas of grout provide a superior protection for any stabilized contaminant that might remain in the waste tank. [WSRC-STI-2007-00369] The reducing grout properties associated with the grout used in Tanks 5F, 6F, 12H, 16H, 18F, and 19F were taken from the specifications in *Tanks 18 and 19-F Structural Flowable Grout Fill Material Evaluation and Recommendations* (SRNL-STI-2011-00551), which were based on testing of grout formulas for waste tank fill. The FTF and HTF PAs outline the key mechanical and chemical properties used in PA modeling. A grout formula that meets the key specifications will reduce water intrusion, retard migration of residual contaminants, and inhibit a hypothetical future member of the public (MOP), in the case of the Type IV tanks, from drilling into the waste tank.

Except for Tanks 17F and 20F, four types of grout have been used during waste tank and associated equipment closures. The grout names and specification or reference as used in this CGCP are listed in Table 2.3-1.

Table 2.3-1: CGCP Grout Names and Specification or Reference

Commonly Used Names	CGCP Grout Name	Specification or Reference
Bulk-fill grout	Bulk-fill grout	C-SPP-F-00055, Rev. 6
Clean cap grout, Alternative Tank 16 Fill Grout, Alternative fill grout	High-flow grout	C-SPP-Z-00012, Rev. 1
Cooling coil grout	Cooling coil grout	C-SPP-F-00057, Rev. 2
Equipment fill grout	Equipment fill grout	Mixture T1a-62.5FA.400 is used and the formulation is in SRNL-STI-2011-00592, Rev. 0
--	Alternate grout	Potential use of an alternate grout will undergo an evaluation against applicable operational and performance documents. If the evaluation determines that it is acceptable to use the alternate grout, the change will be provided to SCDHEC for their review and approval prior to using the alternate grout[a]

[a] SCDHEC will be approving the use of the alternate grout and not the procurement specification for the alternate grout.

The waste tank risers will be modified, as needed, to permit grout placement into the waste tank. Video cameras will be used during the grout pouring process to monitor for anomalies and potential void space formations. Each waste tank riser will be filled with grout from the top. Provisions will be made to provide delivery points into the waste tank to manage air displacement, to address bleed water build-up, and to handle any waste tank top overflow. The waste tank will be ventilated until after grouting is complete. The final grouted tank configuration will be reported in the Final Configuration Report (FCR) for each tank.

2.3.3 Annulus Grouting

Grout will be introduced into the annulus between the outside radius of the annulus ventilation duct and the annulus steel pan. Initially, an approximately 6-inch deep grout layer will be placed in the annulus to support the horizontal ductwork sections during grouting. The ductwork will then be filled through the vertical inlet piping system to the extent practicable, or until grout is observed exiting through the vent openings on top of the ductwork. As the annulus fill level is raised, grout will flow through any remaining openings and into any unfilled portions of the horizontal ductwork. Alternately, if the ductwork is sufficiently degraded, it may be more effective to let the ductwork infill from the outside as the annulus grout level is raised. In parallel with bulk filling of the annulus, attempts will be made to keep the grout level inside the vertical inlet ductwork section at approximately the same level as the surrounding annulus grout fill level. This will mitigate the potential for duct collapse because of increased lateral pressure outside the duct. The annulus exhaust riser will be filled to grade level after the bulk fill level reaches the bottom of the riser (i.e., top of annulus). To maintain tank structural requirements, grout will be added alternately into the primary liner and the annulus. The annulus risers will be filled to the level of the riser opening planes.

2.3.4 Cooling Coil Grouting

A different grout formula than the bulk-fill or high-flow grout will be used for the cooling coil grouting. The commercially available cable grout, MF 816, described in *Proposed Strategy for Grouting Type I and II Waste Tank Cooling Coils* (SRR-CWDA-2014-00110) and used for the Tank 16H coils will be prepared and used for cooling coil grouting. The current approach is to flush all intact cooling coils just prior to grout introduction. The flush water will remove chromate cooling water from the coils and will ensure a uniformly wetted path exists for the grout to follow. Cooling coil flushing will be performed using an approved work package to ensure that any chromate-laden water is properly handled and dispositioned. An initial grout layer will be placed into the primary tank prior to any cooling coil grouting to support the bases of the vertical cooling coils and help prevent failure during grouting.

Coils that have been severed will be grouted from each end to the extent practicable. There may be coil sections isolated by breaks and no longer connected to the coil inlets and/or outlets that cannot be filled internally. Coils that are no longer intact (e.g., failed with a guillotine break) will only be filled passively as the bulk-fill grout is added to the tank.

2.3.5 Abandoned Equipment Grouting

Some equipment inside the primary tank or annulus, such as submersible pumps, conductivity probes, and transfer jets will be abandoned in place. The equipment will be entombed as the bulk-fill grout level rises, while the internal void space will be filled to the extent practicable with equipment fill grout. This equipment fill grout is similar to the cooling coil grout, except that it is more flowable. The formulation is described in *Tank 18 and 19-F Equipment Grout Fill Material Evaluation and Recommendations* (SRNL-STI-2011-00592). Because of the small volume involved, it is usually mixed by hand and added by hand pouring into the equipment opening(s) on the tank top.

2.3.6 Transfer Lines

There are no current plans to add fill material to the FTF or HTF transfer lines. Flushing of the transfer lines after use has long been practiced for waste transfers to prevent material build up within the systems. Transfer line core pipe flushing has been part of operations of the waste tank farms from at least the mid-1970s, and there is also indication that some level of flushing has always been a part of transfer system operations. The rigor to which flushing has been applied has increased over the years and has been a requirement from the safety basis documents in the recent past. In addition to operational practices of flushing, specific design practices have contributed to removing the waste from waste transfer line piping systems. The installation of stainless steel for the waste transfer core piping, the transfer piping sloping toward a waste tank with minimal valves, and the layout of turn radii are specific design features that prevent waste accumulation in the piping systems. The waste transfer lines were modeled without grout in the both the FTF and HTF PAs and the results were in compliance with the required performance objectives. Since any residual radioactive waste would be on the interior wall of the transfer lines and the leach rate would not be significantly influenced by grout, there is no environmental benefit to grouting these small diameter transfer lines. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Waste tank system stabilization options will continue to be evaluated throughout the FTF and the HTF RFS process.

3.0 MAINTENANCE AND MONITORING

The FFA directs the comprehensive remediation of SRS. It contains requirements for site investigation and remediation of releases and potential releases of hazardous substances and expands the site investigation process begun at SRS to address releases of hazardous or radioactive substances. The agreement also establishes requirements for the prevention and mitigation of releases or potential releases at, or from, FTF and HTF, and the remediation of soils and groundwater when all FTF and HTF waste tanks have been removed from service. Because not all waste tank systems will be closed at the same time, there will be an interim period where some systems remain operational while others are closed. [WSRC-OS-94-42]

Following removal of a waste tank or group of waste tanks and/or ancillary structures from service, the waste tank(s) or structure(s) will be removed from Construction Permit #17,424-IW via an Explanation of Significant Difference (ESD) to the applicable Interim Record of Decision (IROD) for the FTF or HTF. Maintenance and monitoring of the waste tank(s) after removal from service until final FFA corrective/remedial actions will be governed by the IROD and the RCRA permit. The interim period controls are provided in the IROD. Groundwater monitoring will be conducted during the interim period from the time the individual waste tanks and ancillary structures are removed from service up to the final closure of the FTF and HTF OU in accordance with the approved groundwater monitoring plans for FTF and HTF. [SRNS-RP-2011-00995, SRNS-RP-2012-00287, SRNS-RP-2012-00146] These plans include elements such as a groundwater monitoring network, sampling frequency, constituents and associated detection limits, reporting frequency, and triggers for evaluation of corrective action. In the interim period following RFS until application of the IROD/RCRA Permit Modification and any subsequent needed final FFA corrective/remedial actions, closed tanks will be subject to the following maintenance and monitoring requirements:

- Continue groundwater monitoring as requested by SCDHEC in support of Construction Permit #17,424-IW. The *F-Area Tank Farm Groundwater Monitoring Plan*, (SRNS-RP-2011-00995) will be used for groundwater monitoring for FTF. The *H-Area Tank Farm Groundwater Monitoring Plan and Sampling and Analysis Plan* (SRNS-RP-2012-00146) provide the requirements for groundwater monitoring for HTF. The analysis of groundwater samples will be performed by a laboratory certified for applicable parameters in accordance with SCDHEC R.61-81, *State Environmental Laboratory Certification Program*. Results have been and will continue to be reported annually to SCDHEC and EPA.
- Conduct annual visual inspections of the risers and area surrounding the RFS waste tank(s) and perform maintenance actions as appropriate. The grout is the primary barrier to contaminant release. The grout, where visible, will be inspected for significant cracking. The area stormwater system will be maintained to ensure that any possible water infiltration through grout is minimized. Conditions that will be inspected will include, at a minimum, excessive water accumulation in surrounding areas and physical integrity of visible installed barriers. Within 30 days of detection, DOE will notify SCDHEC of any significant cracking of the grout or degradation of the stormwater system and will establish a schedule to complete necessary maintenance activities.

Inspection records will be maintained until all tanks have been removed from service and both the FTF and HTF OUs are closed.

- Provide access controls for on-site workers via the Site Use Program, Site Clearance Program, work control, worker training, worker briefing of health and safety requirements, and identification signs located at the waste unit boundaries.
- Notify the EPA and SCDHEC in advance of any changes in land use in accordance with the *Savannah River Site Land Use Plan* (SRNS-RP-2013-00162).
- Provide access controls against trespassers as consistent with the 2000 RCRA Part B Permit Application, Volume I, Section F.1, which describes the security procedures and equipment, 24-hour surveillance system, artificial or natural barriers, control entry systems, and warning signs in place at the SRS boundary. [WSRC-IM-98-30]

Once removal from service of all waste tanks and ancillary structures is complete, a decision for the final area closure under the FFA can be established by a final ROD/permit modification as provided for in the FFA. The maintenance requirements will be addressed in future plans that will be developed in concert with SCDHEC and EPA at that time. In developing those plans, consideration will be given to inclusion of such elements as a groundwater monitoring network, sampling frequency, constituents and associated detection limits, reporting frequency, and triggers for evaluation of corrective action.

4.0 WASTE TANK DESCRIPTIONS

There are 51 underground liquid radioactive waste storage tanks at SRS. Twenty-two waste tanks are located in the FTF and 29 waste tanks are in the HTF. The main component of a waste tank is the primary liner that contains the liquid waste. The primary liners are cylindrical and made of carbon steel. There are four principal waste tank designs designated as Type I, II, III/IIIA, and IV.

The Type I and II primary liners are partially enclosed by a larger diameter, secondary liner (annulus pan) also made of carbon steel. The difference in primary and secondary liner diameters creates an annulus, which varies in size and capacity for each waste tank type. The secondary liner serves as a collection point for any leakage from the primary liner. An annulus ventilation system makes additional cooling of the exterior primary liner wall and control of the annulus air humidity possible. Most Type I and II tanks have a positive pressure annulus ventilation system while Type III/IIIA tanks have a negative pressure annulus ventilation system. [WSRC-SA-2002-00007] The Type IV tanks do not have a secondary liner.

A reinforced concrete vault surrounds the primary liner of Type IV tanks and the secondary liners of Type I, II, and III/IIIA tanks and provides structural support and radiation shielding. The lowest part of the concrete vault is called the basemat and beneath the basemat of the Type I, II, and III/IIIA tanks is a working slab that was used as a foundation for the initial waste tank site construction. No working slab was used for the Type IV tank constructions.

The primary cooling method for the stored liquid waste uses a system of cooling coils (pipes) inside the primary liner. The cooling coils use chromated water for corrosion control and heat transfer. Cooling coils are installed in Type I, II, and III/IIIA tanks and the designs vary by waste tank type. Type IV tanks do not have cooling coils.

Risers on the tank top provide access to the primary tank and annulus interiors and are typically used for inspection and equipment insertion. Lead or concrete plugs are inserted into riser openings if no equipment is installed. Riser layout is dependent on the specific waste tank design.

The waste tanks were constructed during different time periods and design features were changed to incorporate improvements. Table 4.0-1 summarizes the FTF and HTF waste tank design types. Specific waste tank design and construction information is provided in Section 3 of the associated FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Table 4.0-1: Summary of FTF/HTF Waste Tank Design Types

Tank Number	Tank Farm	Design Type	Year Constructed	Volume (gallons)[a]
1 - 8	F	I	1952	750,000
9 - 12	H	I	1953	750,000
13 - 16	H	II	1956	1,070,000
17 - 20	F	IV	1958	1,300,000
21 - 24	H	IV	1961-1962	1,300,000
25 - 28	F	IIIA	1978	1,300,000
29 - 32	H	III	1970	1,300,000
33	F	III	1969	1,300,000
34	F	III	1972	1,300,000
35 - 43	H	IIIA	1976-1979	1,300,000
44 - 47	F	IIIA	1980	1,300,000
48 - 51	H	IIIA	1981	1,300,000

[a] Nominal fill capacity.

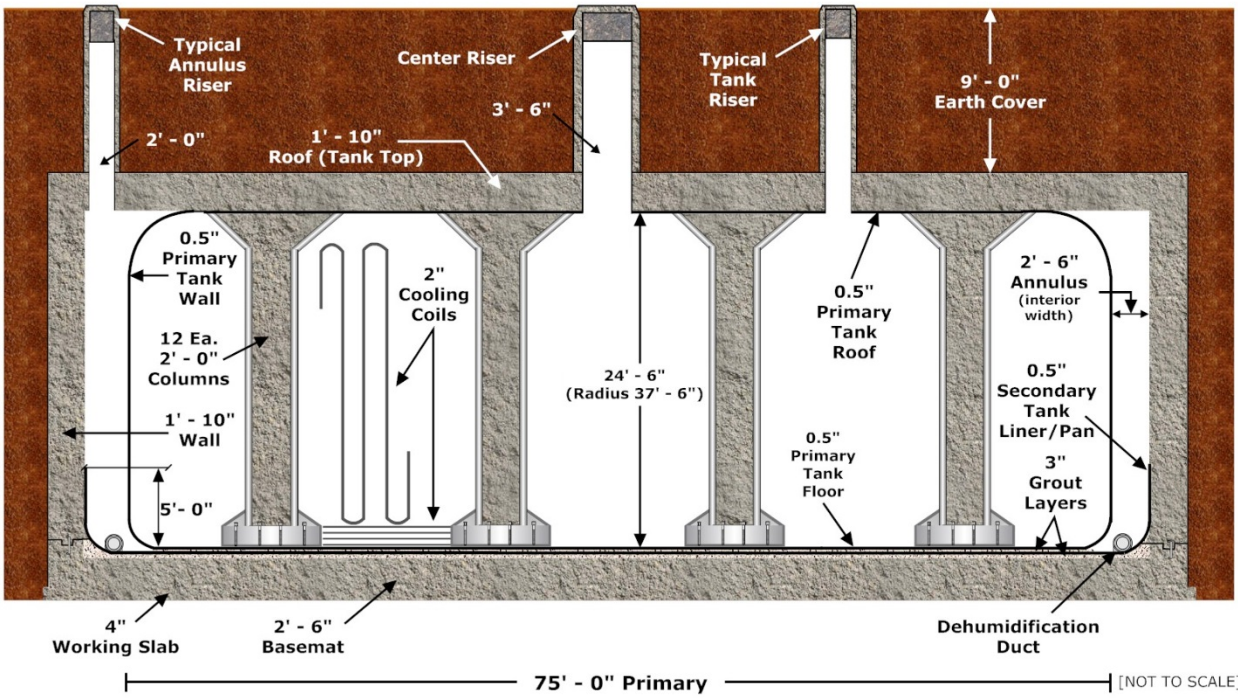
4.1 Type I Tanks

There are eight Type I tanks in FTF and four Type I tanks in HTF; all were constructed in the early 1950s (Table 4.0-1). The Type I tank tops in both FTF and HTF are approximately nine feet below grade. A typical Type I tank cross-section is shown in Figure 4.1-1. Additional details for the Type I tanks are provided in Section 3 of the associated FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

4.1.1 Type I Tank Primary and Secondary Liners

Type I tank primary liners have a 75-foot inside diameter and are 24 feet 6 inches high with a nominal operating capacity of 750,000 gallons. [SRR-CWDA-2010-00128, N-ESR-G-00001] The primary liner sits inside a 5-foot high, 79-foot 11-inch inside diameter secondary liner (annulus pan). The primary and secondary liners are enclosed within an 83-foot 8-inch outside diameter concrete vault that creates an approximately 2-foot 5.5-inch wide annular space (Figure 4.1-1).

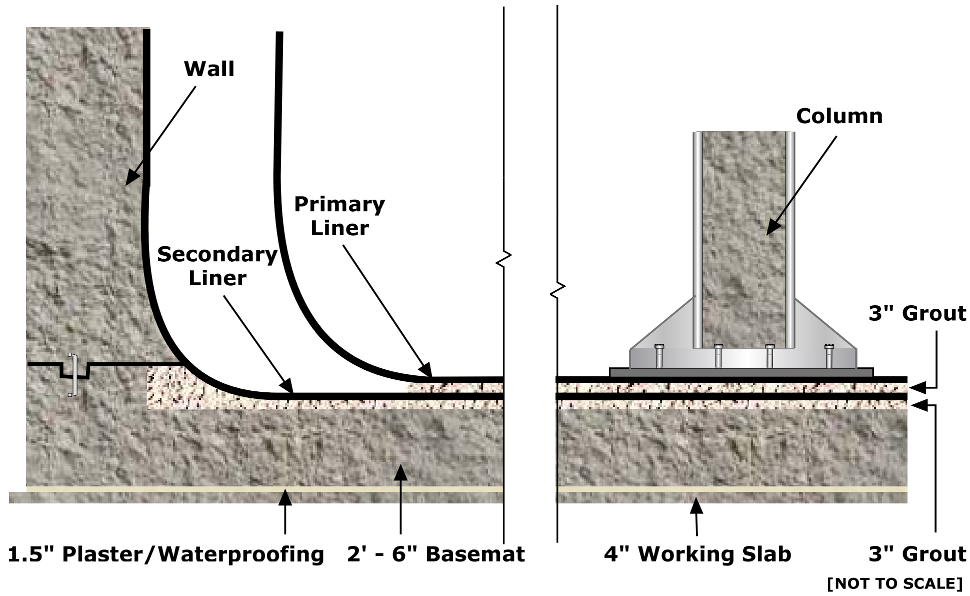
Figure 4.1-1: Typical Type I Tank Cross-Section



The Type I primary liner is made of 0.5-inch thick carbon steel. The liner wall is joined to the primary liner roof and floor with non-stress-relieved welded knuckle plates also made of carbon steel. The secondary liner is also made of 0.5-inch thick carbon steel. The top edge of the secondary liner has an L-shaped carbon steel stiffener lip that extends 6 inches perpendicularly inward from the liner edge with another 4-inch long section extending perpendicularly down from that edge. [W145367]

The primary liner rests on a 3-inch thick layer of grout inside the secondary liner and the secondary liner sits on a 3-inch thick grout layer on top of the concrete basemat (Figure 4.1-2).

Figure 4.1-2: Typical Type I Tank Floor Configuration

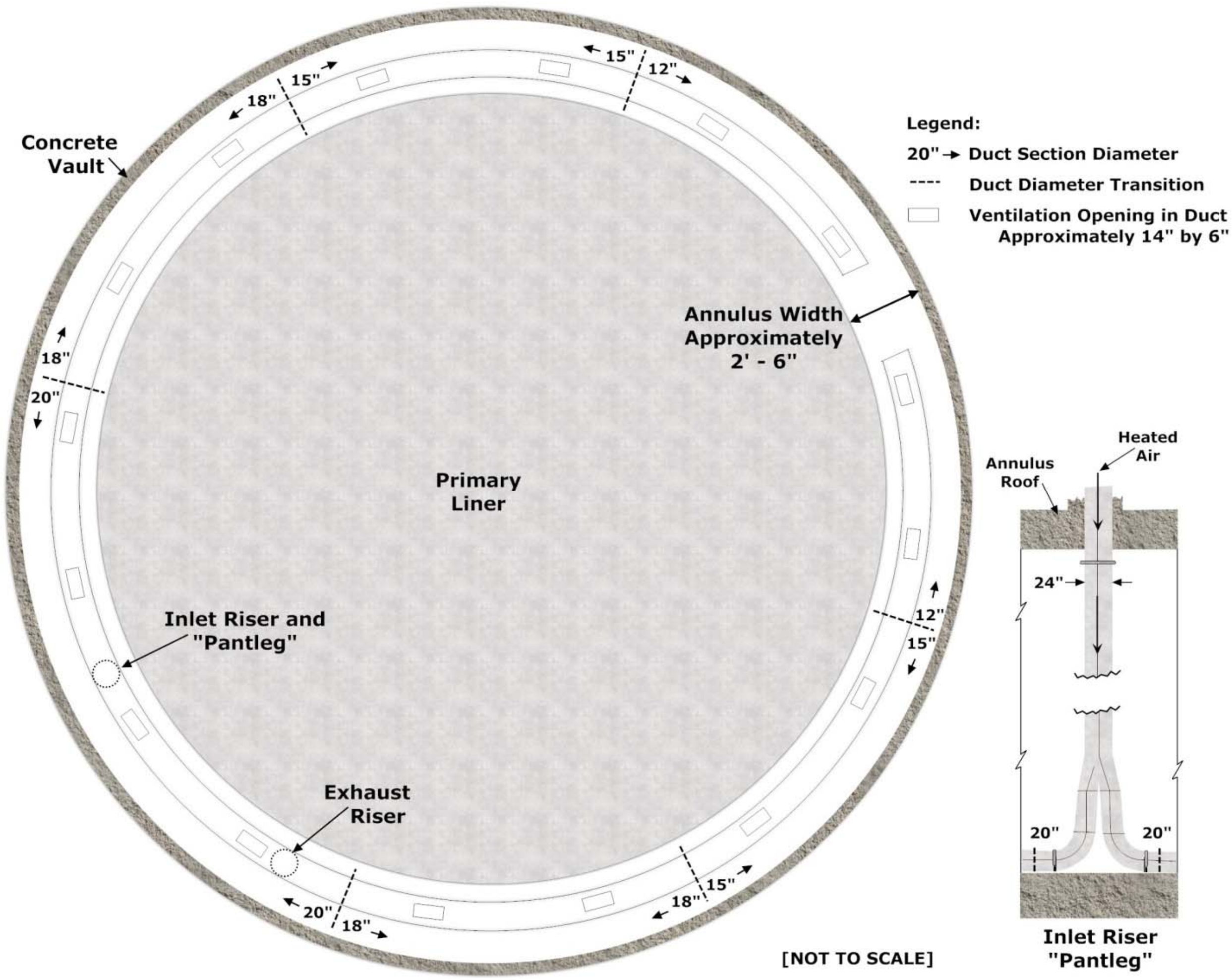


4.1.2 Annulus Dehumidification System

A dehumidification ductwork system was installed on the secondary liner floor to keep the annular space dry by circulating warm air at a temperature above its dew point. Dehumidification equipment consisting of an above-ground heater and fan connect to the ductwork inlet via the annulus inlet riser. The exhaust is vented through a separate annulus riser into a High-Efficiency Particulate Air (HEPA) filter system. The system details vary slightly between waste tanks and a typical ductwork system is shown in Figure 4.1-3. [W163389]

During operation, the heated air is introduced through a 24-inch diameter annulus inlet riser into the ductwork where the flow is divided via the “pantlegs” into two separate ductwork sections, with one section running clockwise and the other counterclockwise (Figure 4.1-3). The sections both terminate approximately 180 degrees away from the inflow point leaving a gap between the ends. The distal ends are closed off. The ductwork sections vary in diameter from a maximum of 20 inches at the pantlegs to a minimum of 12 inches at the distal ends. The airflow exits the ductwork through eight, 14-inch long by 6-inch wide openings that are equally spaced along the top of each ductwork section (16 total).

Figure 4.1-3: Annulus Dehumidification Ductwork System Diagram



4.1.3 Type I Tank Concrete Vault

An 83-foot 8-inch outside diameter concrete vault encloses a Type I tank. The vault is formed by the 1-foot 10-inch thick reinforced concrete roof and wall that surround the primary and secondary liners and connects to the basemat. The space between the vault and the primary liner creates a 2-foot 5.5-inch wide annulus. The vault wall was constructed using only horizontal construction joints. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

The Type I tank tops in the FTF and HTF are approximately nine feet below grade. For the Type I tanks in HTF, the tank tops are several feet below the mean water table elevation and because of this, waterproofing measures were incorporated into the concrete vault design and construction. Details of the waterproofing methods are in Section 3 of the HTF PA. [SRR-CWDA-2010-00128]

4.1.4 Type I Tank Working Slab and Basemat

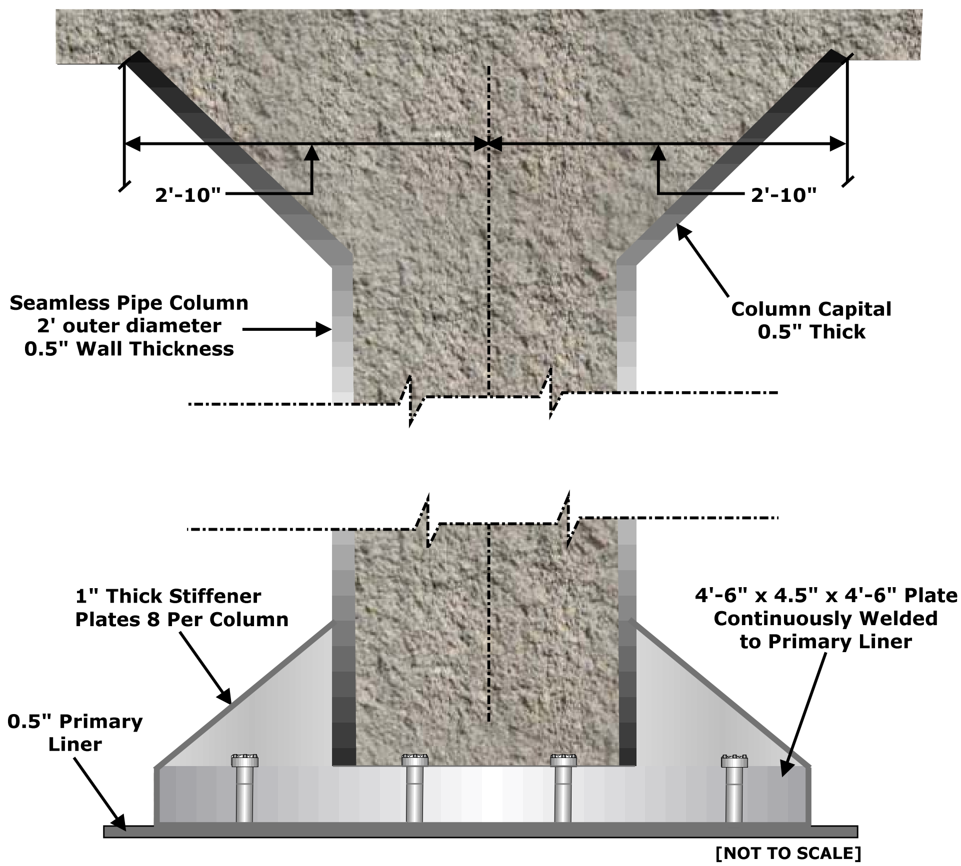
Figure 4.1-2 shows the details of a typical Type I basemat, working slab, and liner floors. The working slab for a Type I tank is 4 inches thick, with a radius of 42 feet 5 inches. A

1.5-inch thick layer of plaster/waterproofing membrane sits above the working slab. A 30-inch thick reinforced concrete base (basemat) sits on top of the plaster. A 3-inch thick layer of construction grout fill sits on top of the basemat and the secondary liner rests on the grout. A 3-inch thick layer of grout lies between the bottom of the primary liner and the secondary liner. [SRR-CWDA-2010-00128]

4.1.5 Type I Tank Support Columns

The Type I tank roof is supported by 12 internal columns. Figure 4.1-4 shows the details for one of the support columns. These columns are 2-foot outside diameter, 0.5-inch thick carbon steel pipes filled with reinforced concrete. The columns have flared concrete-filled capitals at the top that are welded to the primary liner roof. The column base is welded to a base plate and anchored by welded vertical stiffener plates, and the base plate is welded to the primary liner floor. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

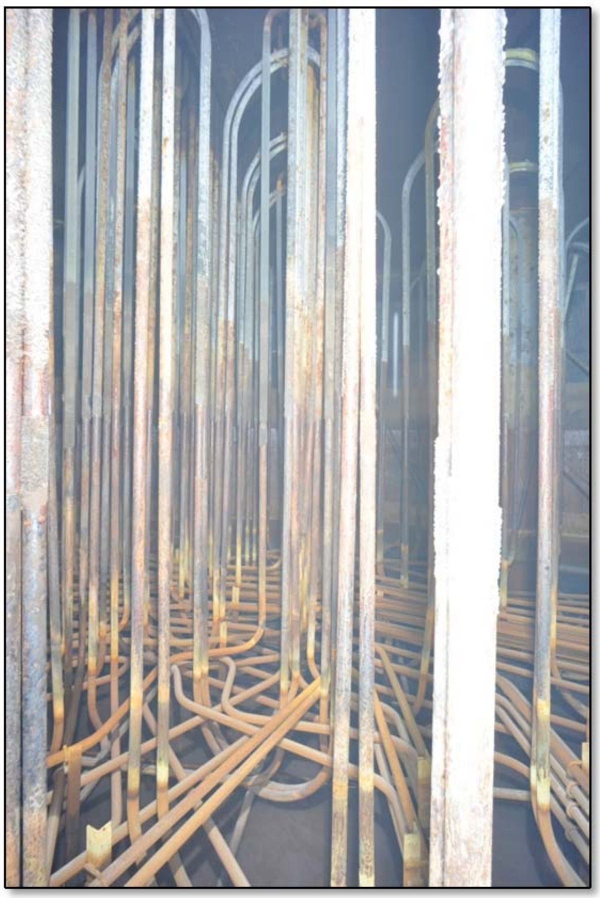
Figure 4.1-4: Type I Tank Support Column Dimension Details



4.1.6 Type I Tank Cooling Coils

Type I tanks contain horizontal and vertical arrays of 2-inch inside diameter Schedule 40 carbon steel pipe cooling coils (Figure 4.1-5). Each Type I tank contains 34 vertical cooling coils consisting of 604 vertical sections 18.5 feet long with 604 half-loops connecting the vertical sections. The cooling coils are supported by hanger and guide rods welded to the waste tank roof. Two horizontal cooling coil arrays crisscross the bottom of the waste tank and are supported by guide rods and angle iron struts welded to the waste tank floor. The lowest horizontal cooling coil is approximately 1 inch above the waste tank floor and the upper horizontal cooling coil is approximately 4 inches above the floor. The horizontal coils consist of 26 horizontal sections and 26 half-loops connecting the horizontal sections that were "field to fit" during their installation. The cooling water supply system pipes pass through the primary liner roof and flow is controlled in a valve house on the waste tank top. There are approximately 22,800 linear feet of cooling coils in a Type I tank. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

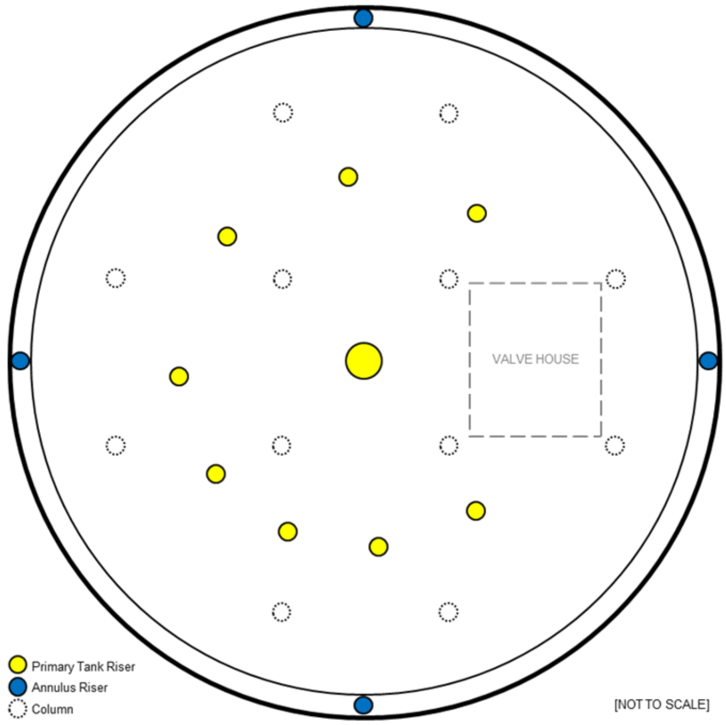
Figure 4.1-5: Type I Tank (Tank 12H) Cooling Coils



4.1.7 Type I Tank Access and Riser Configuration

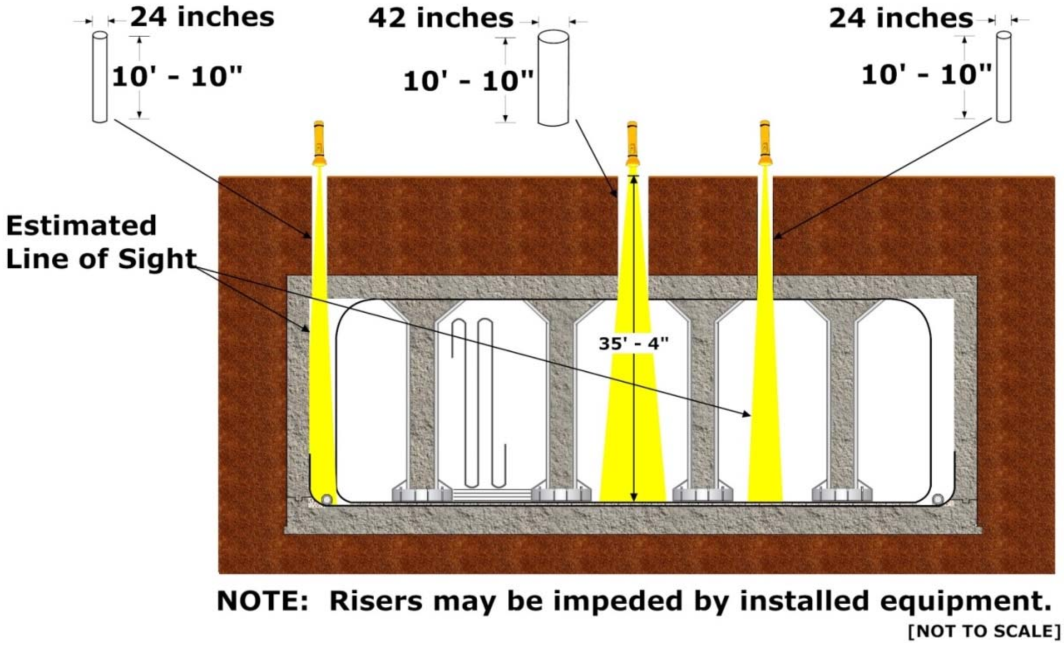
As originally designed and constructed, Type I tank roofs have nine primary liner and four annulus access risers. Type I primary tanks have one 42-inch diameter center riser and eight 24-inch diameter risers arranged in a circular pattern around the center riser. Each quadrant of the annulus contains a 24-inch diameter riser (Figure 4.1-6).

Figure 4.1-6: Typical Type I Tank Primary Liner and Annulus Riser Configuration



Access to a Type I tank interior is limited by the as-built riser size and arrangement, and distance from ground surface to the waste tank floor. As shown in Figure 4.1-7, riser dimensions restrict direct views of the waste tank floor to small circular areas beneath the risers. Tool manipulations and equipment types that can be successfully deployed are also limited by the as-built riser size, depth below grade, and proximity to obstructions such as cooling coils, columns, and equipment in adjacent risers. Riser use may also be blocked by installed or abandoned equipment such as thermocouples, conductivity probes, pumps, or transfer jets.

Figure 4.1-7: Typical Type I Tank Access Risers



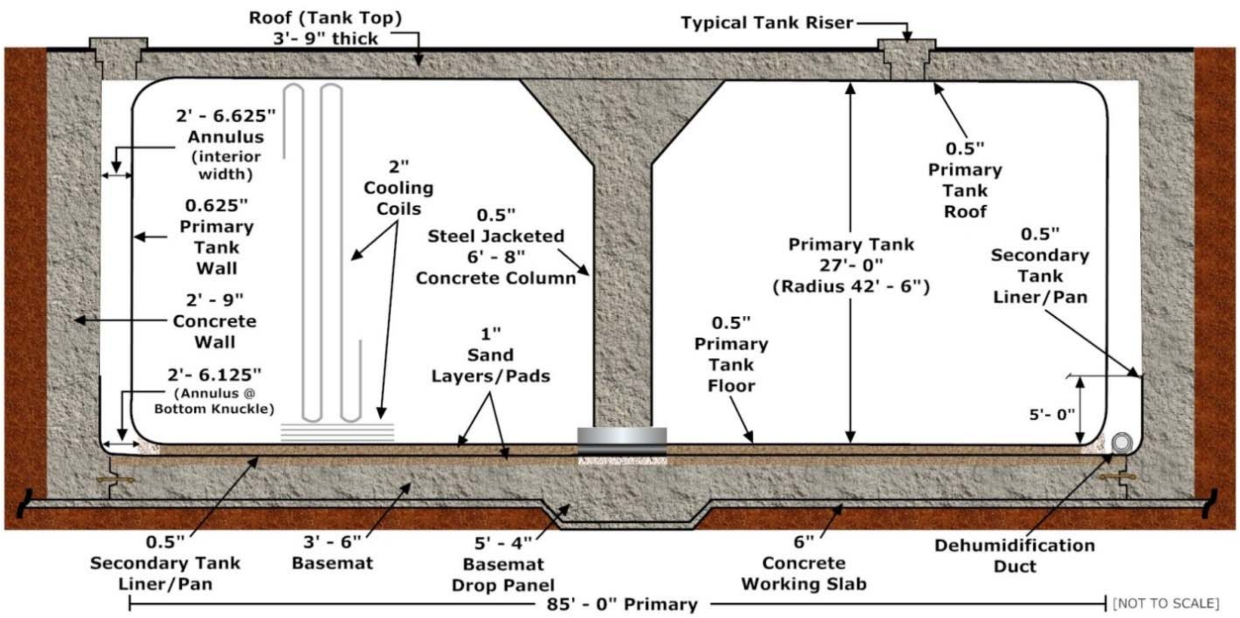
4.2 Type II Tanks

There are no Type II tanks in the FTF. The four Type II tanks in the HTF were constructed between 1955 and 1956 (Table 4.0-1). A typical Type II tank cross-section is shown in Figure 4.2-1. Additional details for the Type II tanks are provided in Section 3 of the HTF PA. [SRR-CWDA-2010-00128]

4.2.1 Type II Tank Primary and Secondary Liners

The Type II tank primary liners have an 85-foot inside diameter and are 27 feet high with a nominal operating capacity of 1,070,000 gallons. [WSRC-SA-2002-00007] The primary liner sits inside a 5-foot high, approximately 90-foot 1.25-inch inside diameter secondary liner (annulus pan). The primary and secondary liners are enclosed within a 95-foot 8.5-inch outside diameter concrete vault that creates an approximately 2-foot 6.625-inch wide annular space (Figure 4.2-1).

Figure 4.2-1: Typical Type II Tank Cross-Section



The primary liner is made of 0.625-inch thick carbon steel. The liner wall is joined to the primary liner roof and floor with non-stress relieved welded knuckle plates also made of carbon steel. The secondary liner is made of 0.5-inch thick carbon steel. [W162688] The top edge of the secondary liner has an L-shaped carbon steel stiffener lip that extends 6 inches perpendicularly inward from the liner edge with another 4-inch long section extending perpendicularly down from that edge.

The primary liner was constructed above a 1-inch thick sand pad placed on top of the secondary liner. An additional 1-inch thick sand pad is between the secondary liner and the basemat (Figure 4.2-1).

A dehumidification system as described in Section 4.1.2 and shown on Figure 4.1-3 is also installed in the annulus of the Type II tanks.

4.2.2 Type II Tank Concrete Vault

A 95-foot 8.5-inch outer diameter concrete vault encloses a Type II tank. The vault is formed by the 3-foot 9-inch thick reinforced concrete roof and 2-foot 9-inch thick reinforced concrete wall that surround the primary and secondary liners and connect to the basemat. The space between the vault and the primary liner creates a 2-foot 6.625-inch wide annulus. [SRR-CWDA-2010-00128]

The base of each Type II tank in HTF is approximately 6 feet 6 inches below the mean elevation of the HTF water table. [SRR-CWDA-2010-00128]

4.2.3 Type II Tank Working Slab and Basemat

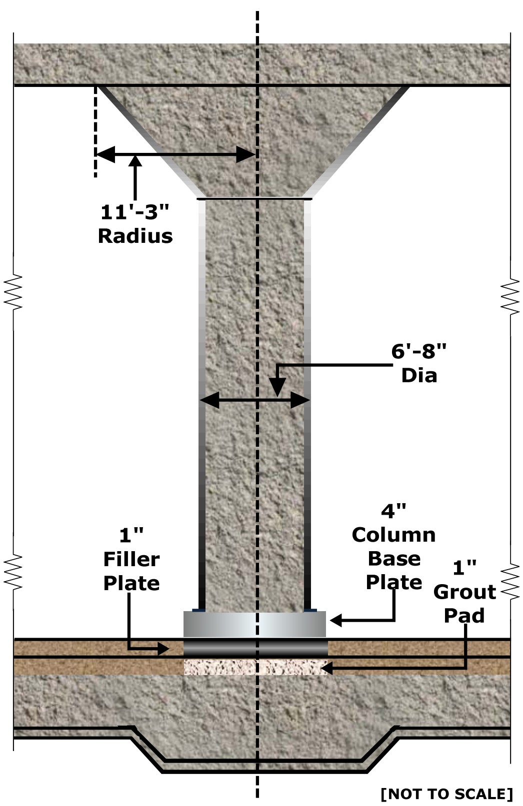
Four HTF Type II tanks (Tanks 13H through 16H) were constructed within a 255- by 274-foot rectangle. The working slab under the rectangle is 6 inches thick with a 3-foot 6-inch thick reinforced concrete basemat on top of the working slab. There are 1-inch thick layers of leveling sand between the basemat and the secondary liner and between the secondary liner and primary waste tank floor (Figure 4.2-1). The sand layers are contained by an outer ribbon of "Sika-Igas™." [DP-1358]

A soil hydration system and five feed wells were installed beneath the Type II tank rectangle prior to the basemat construction to address potential issues with soil shrinkage and settlement. It was never used for this purpose since the average water table elevation is above the waste tank bottoms and soil dehydration is not a problem. The system has been used in the past to monitor groundwater levels and as part of the Tank 16H groundwater monitoring effort. Additional hydration system construction details are in the HTF PA. [SRR-CWDA-2010-00128]

4.2.4 Type II Tank Support Column

The Type II tank roof is supported by one central column (Figure 4.2-1). The column is made of 0.5-inch thick carbon steel and has an inside diameter of 6 feet 8 inches. During construction, the column was first welded to a steel bottom plate, rebar was installed internally for reinforcement, and then the column was filled with concrete (Figure 4.2-2).

Figure 4.2-2: Type II Tank Support Column Dimension Details



4.2.5 Type II Tank Cooling Coils

Type II tanks contain horizontal and vertical arrays of 2-inch inside diameter Schedule 40 carbon steel pipe cooling coils (Figure 4.2-3). Each Type II waste tank contains 40 vertical cooling coils arranged in 20 sections (rows) approximately 24 feet high supported by hanger and guide rods that are welded to the roof and floor of the primary liner. The coils nearest the central support column were field fitted and are shorter. Four horizontal cooling coil arrays crisscross the bottom of the waste tank and are supported by guide rods and steel angles welded to the waste tank floor. The floor coils are generally arranged in 20 row runs set at 90 degrees to each other. The centerline of the upper and lower coil run pipes are 5 inches and 2 inches above the floor, respectively. In some areas the runs are parallel and coils are stacked four high (Figure 4.2-3). The cooling water supply system pipes pass through the primary liner roof and flow is controlled in a valve house on the waste tank top. There are approximately 29,400 linear feet of cooling coils in a Type II tank. [SRR-CWDA-2010-00128]

Figure 4.2-3: Type II Tank (Tank 16H) Center Column and Cooling Coils

4.2.6 Type II Tank Access and Riser Configuration

As originally designed and constructed, Type II tank roofs have eleven primary liner and four annulus access risers. Ten of the primary liner risers are 24 inches in diameter and the eleventh access riser is 42 inches in diameter. Each quadrant of the annulus contains a 30-inch diameter access riser (Figure 4.2-4).

Access to a Type II primary liner interior is limited by the as-built riser size and arrangement. As shown in Figure 4.2-5, riser dimensions restrict direct views of the waste tank floor to small circular areas beneath the risers. Tool manipulations and equipment types that can be successfully deployed are also limited by the as-built riser size, vault roof thickness, and proximity to obstructions such as cooling coils and equipment in adjacent risers. Riser use may also be blocked by installed or abandoned equipment such as thermocouples, conductivity probes, pumps, or transfer jets.

Figure 4.2-4: Typical Type II Tank Primary Liner and Annulus Riser Configuration

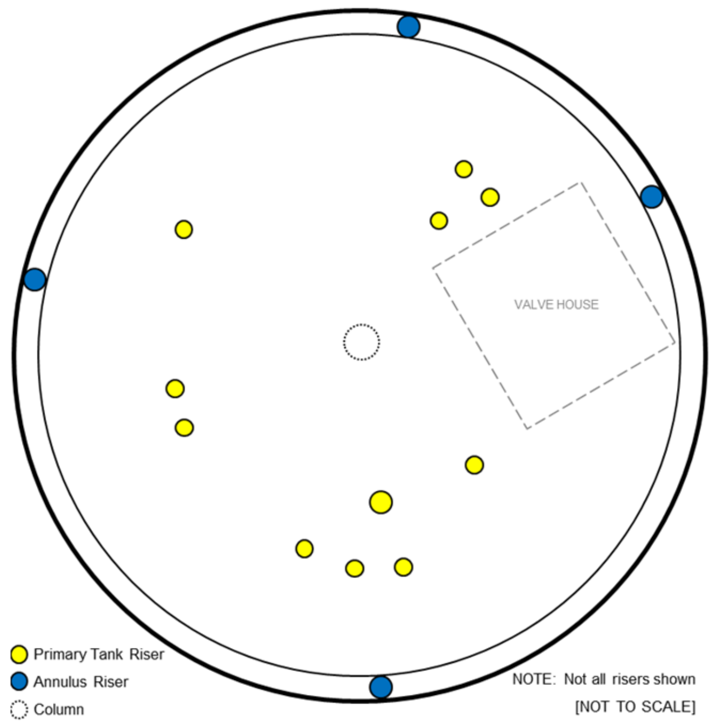
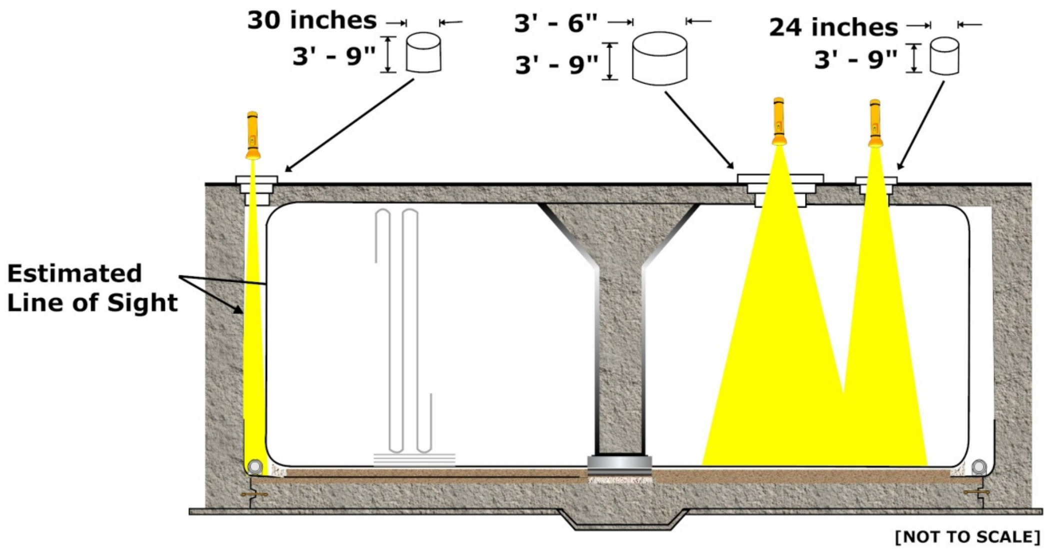


Figure 4.2-5: Typical Type II Tank Access Risers



4.3 Type III/IIIA Tanks

There are two Type III tanks and eight Type IIIA tanks in the FTF. There are four Type III tanks and thirteen Type IIIA tanks in the HTF. The waste tank numbers, associated tank farm, and construction years are listed in Table 4.0-1. All Type III and IIIA tanks have an operating capacity of 1,300,000 gallons.

Construction details differ between Type III and IIIA tanks, but the major difference is the type of cooling coils used inside the primary liner. Type III tanks used deployable coolers that were inserted into the primary liner through the risers while Type IIIA tanks have permanently installed cooling coils (Figures 4.3-1 and 4.3-2). The only exception to this is Tank 35, which is a Type IIIA, but has insertable cooling coils.

Type III/IIIA tanks also have an air ventilation/cooling system embedded in the center support column with supply ducts extending to the radial air grooves built into the insulating grout layer between the primary and secondary liners. Typical Type III and Type IIIA tank cross-sections are shown in Figures 4.3-1 and 4.3-2, respectively. Specific details for the Type III and IIIA tanks in each tank farm are provided in Section 3 of the associated FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Figure 4.3-1: Typical Type III Tank Cross-Section

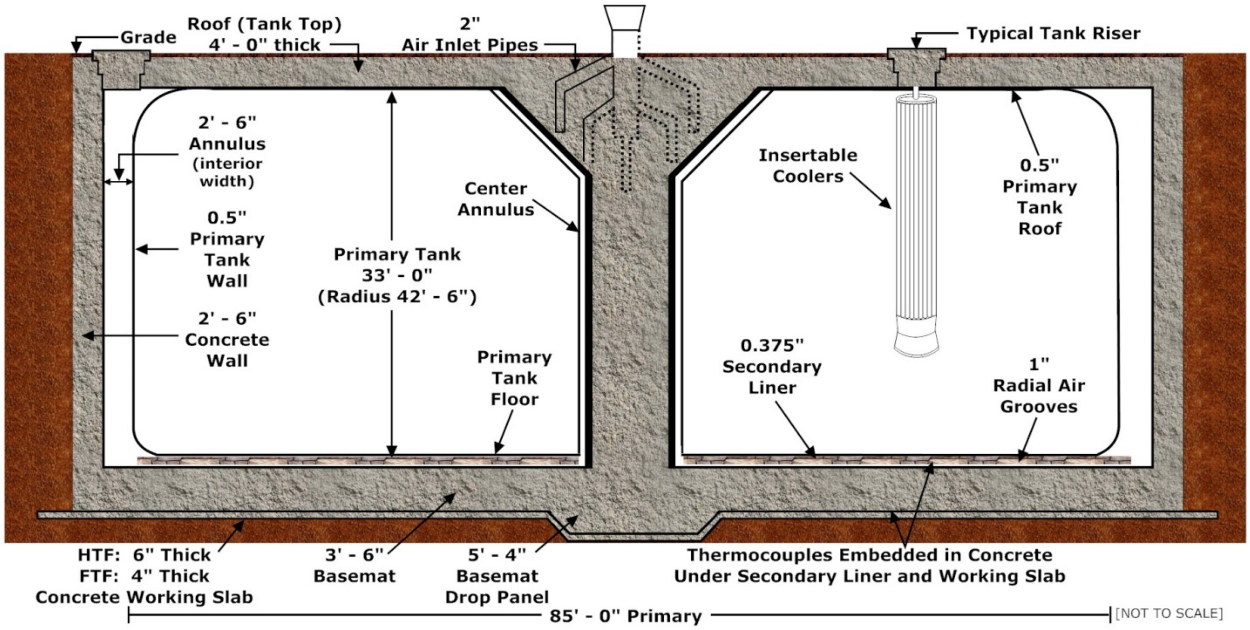
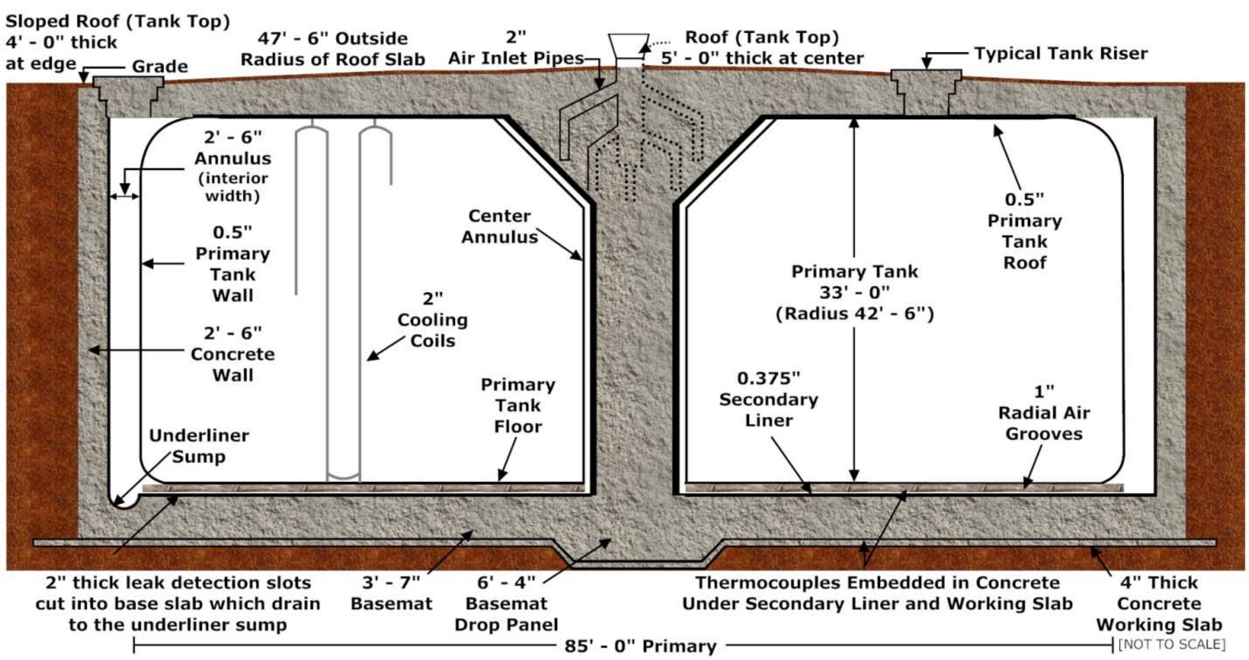


Figure 4.3-2: Typical Type IIIA Tank Cross-Section



4.3.1 Type III/IIIA Tank Primary and Secondary Liners

The primary liner in a Type III/IIIA tank is 85 feet in diameter and 33 feet high with a nominal operating capacity of 1,300,000 gallons. [SRR-CWDA-2010-00128] Type III/IIIA tanks have both a center and outer annulus. The center annulus is formed between the primary liner wall and the roof support column (Figures 4.3-1 and 4.3-2).

The Type III/IIIA primary liner is made of 0.5-inch thick concentric carbon steel cylinders joined to circular top and bottom plates by curved knuckle plates. After construction, the Type III/IIIA primary liners were fully stress-relieved by heating to help prevent cracking. The Type III/IIIA secondary liner is 0.375-inch thick carbon steel and is the full height of the primary liner with a 90-foot 1.75-inch outside diameter forming a 2-foot 6-inch wide annular space between the primary and secondary liners (Figures 4.3-1 and 4.3-2). [W702700]

The primary liner sits on a bed of insulating material with a system of grooves radiating outward from the base of the central column so that ventilating air can flow through the slots, and any leakage from the primary liner bottom, or in the annulus around the center column, would flow to the outer annulus. The Type III tanks have a 6-inch thick layer of insulating material with 1-inch deep by 2-inch wide grooves. [W236993] The Type IIIA tanks have an 8-inch thick layer of insulating material with 2-inch deep by 5-inch wide grooves. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

4.3.2 Type III/IIIA Tank Concrete Vault

The Type III/IIIA tanks are completely enclosed in a reinforced concrete vault. The vault roof is a minimum of 48 inches thick with 30-inch thick walls. With the exception of Tanks 35H through 37H, Type IIIA tank tops slope and thin from a 5-foot thickness at the tank center, to a 4-foot thickness at the perimeter to promote rainwater drainage. Because of the thick concrete roof, no earthen cover on a Type III/IIIA tank top is required for shielding.

4.3.3 Type III/IIIA Tank Working Slab and Basemat

The construction-working slab for the Type III tanks is a minimum of 6 inches thick and extends at least 30 feet beyond the edge of the waste tank. The working slab for Type IIIA tanks is a minimum of 4 inches thick and extends 25 feet beyond the edge of the waste tank. The excess working slab areas either were broken up or had an extensive network of 4-inch diameter holes drilled through them before the backfill surrounding the waste tanks was placed. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

The basemat is 3 feet 6 inches thick in the Type III and 3 feet 7 inches thick in the Type IIIA tanks with a radius of 45 feet not including the annulus or vault wall. Both waste tank designs have a thicker drop panel section under the central column. The drop panel is 5 feet 4 inches thick under the Type III tanks and 6 feet 4 inches thick under the Type IIIA tanks (Figures 4.3-1 and 4.3-2). [W236562, W238169, SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Type IIIA tanks have an underliner sump between the secondary liner bottom and basemat. A grid of 2-inch deep interconnected radial channels is grooved into the concrete basemat upon which the secondary liner rests. The channels are sloped to drain through a center collection pipe to a sump outside the concrete vault that encloses the waste tank. An access pipe extends to grade from the sump to allow for measurement, sampling, and pump-out of any accumulated liquid. [W703786] The basemat in Type III tanks does not have leak detection channels. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

The Type IIIA tanks also have conductivity probes that pass through the waste tank top concrete into the center annulus. [W238163] Multiple conductivity probes are also installed in the outer annulus to provide redundant leak detection capability. No leakage from the primary liner into the Type III/IIIA secondary liners or concrete vaults has been detected. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

4.3.4 Type III/IIIA Tank Support Column

The Type III/IIIA tank roof is supported by a steel-jacketed, reinforced concrete-filled center support column that was constructed as an integral part of the basemat. The design does not require the waste tank bottom to support the weight of the roof support column, as it does in the Type I and II tanks, thereby reducing stress on the bottom of the primary liner. Reinforcing bars of various lengths were placed throughout the center support column before it was filled with concrete. The central column diameter of 6 feet 2 inches varies slightly between the Type III and IIIA tanks.

Type III/IIIA tanks have an air ventilation/cooling system supply ducts embedded in the center support column that connect to the radial air grooves in the insulating layer between the primary and secondary liners (Figure 4.3-3). [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Figure 4.3-3: Type III/IIIA Tank Central Column and Vent Ductwork Construction Photo

4.3.5 Type III/IIIA Tank Cooling Coils

In the Type III tanks, deployable coolers were inserted into the primary liner through the waste tank risers and three types of cooler designs were used (Figure 4.3-4). The umbrella and cylindrical cooler styles were opened (deployed) after insertion. The consolidated bundle design did not require opening. Tank 29H has nine deployable coils; Tank 31H has seven deployable coils; and Tanks 30H, 32H, and 35H each have five deployable coils.

With the exception of Tank 35H that uses deployable coils, all Type IIIA tanks have permanently installed cooling coils (Figure 4.3-5). The permanent vertical cooling coils are top and bottom supported and spaced on 3-foot triangular centers. There are typically 246 vertical coils mounted 9 inches above the waste tank floor. The bottom supports for the cooling coils are welded to the bottom of the waste tank. All of the cooling coils are 2-inch inside diameter Schedule 40 carbon steel pipe. [W705828, SRS-REG-2007-00002, SRR-CWDA-2010-00128] For the permanently installed coils, the cooling water supply system pipes pass through the primary liner roof and flow is controlled in a valve house on the waste tank top. There are approximately 15,900 linear feet of cooling coils in a Type IIIA tank. [M-CLC-H-02820] Cooling water is supplied to the risers containing deployable cooling coils through above-grade manifolds and piping on the surface of the waste tank roof.

The Type III/IIIA tanks do not have horizontal cooling coil arrays near the waste tank floor. As mentioned above, the Type III/IIIA primary liner bottoms are cooled by the air passing through the central column annulus and out through the radial air grooves in the insulating layer between the primary and secondary liners. [W238160]

Figure 4.3-4: Insertable Coolers Used in Type III Tanks

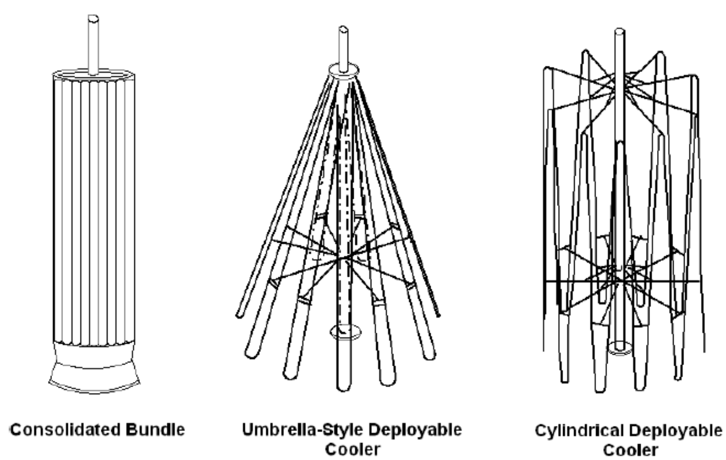
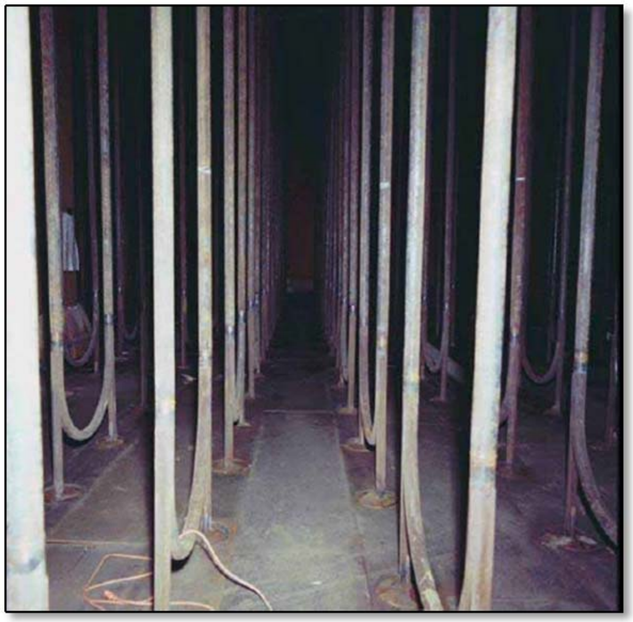


Figure 4.3-5: Cooling Coils in a Type IIIA Tank



4.3.6 Type III/IIIA Tank Access and Riser Configuration

In general, the Type III tanks have a total of 42 risers and Type IIIA tanks have a total of 40 risers for access to the primary and secondary (annulus) liners. [PIT-MISC-0052] Figures 4.3-6 and 4.3-7 show the general configuration of the larger diameter access risers for Type III and IIIA tanks. However, not all risers are usable for access to the primary liner or annulus interiors because of the small diameter or permanently installed equipment.

Type III tanks typically have ten 3-foot diameter risers in the primary liner roof available for deployable cooler insertion. There are four 2-foot 6-inch diameter risers for annulus access. [W236519]

Type IIIA tanks generally have five 3-foot diameter risers and two 4-foot 4-inch diameter risers in the primary liner roof. There are four 2-foot 6-inch diameter risers for annulus access [W700757, W700340].

Figure 4.3-6: Typical Type III Tank Riser Configuration

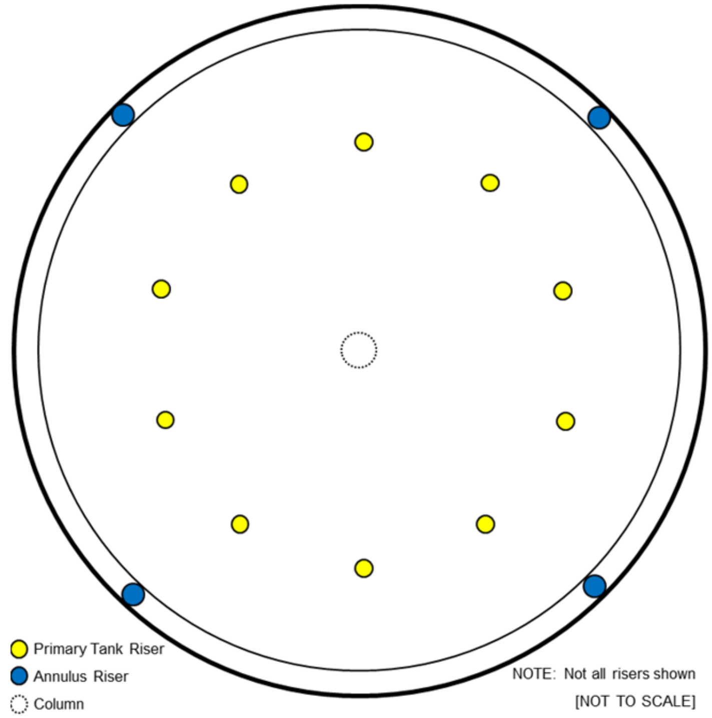
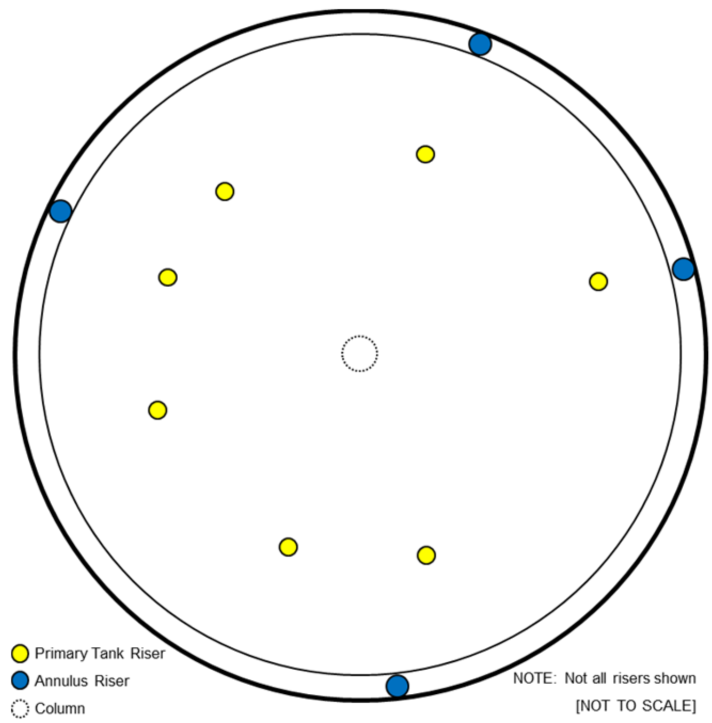


Figure 4.3-7: Typical Type IIIA Tank Riser Configuration

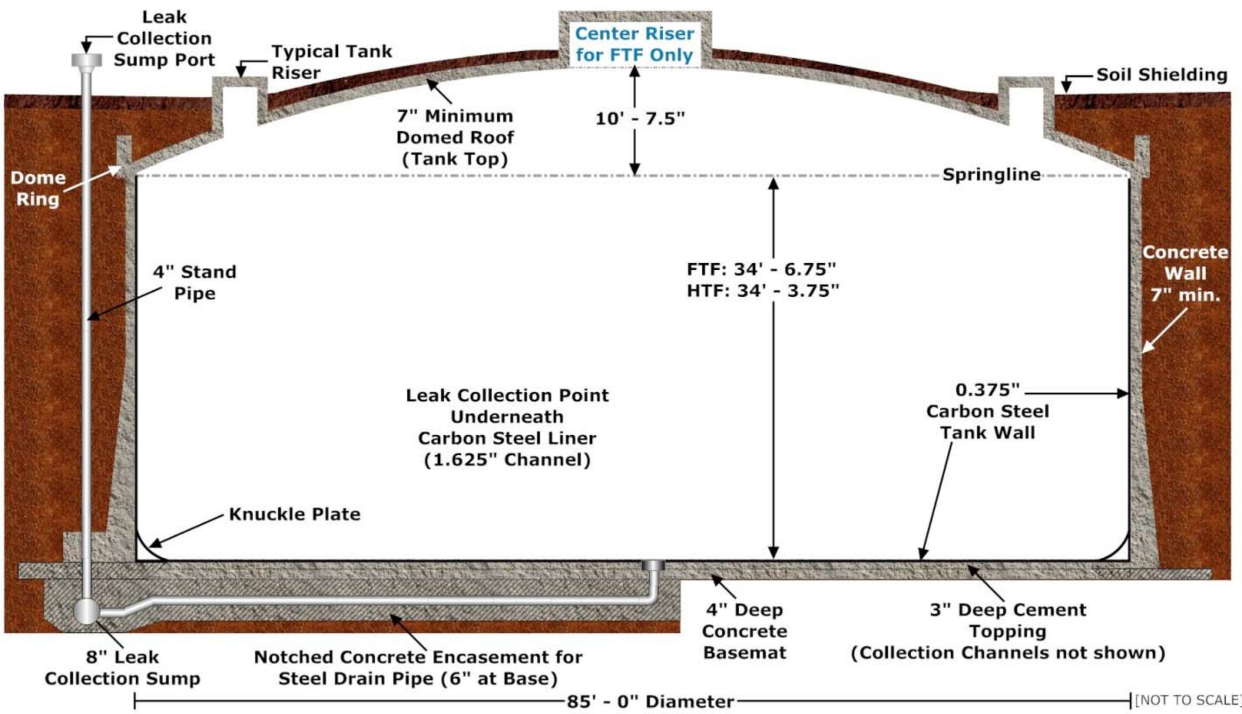


4.4 Type IV Tanks

There are four Type IV tanks in FTF that were constructed during the late 1950s and four Type IV tanks in HTF that were constructed between 1958 and 1962 (Table 4.0-1). Type IV tanks have a single carbon steel primary liner with a hemispherical, reinforced concrete roof. The Type IV tanks in FTF have a center roof riser, while those in HTF do not. A typical Type IV tank cross-section is shown in Figure 4.4-1. Additional details on the Type IV tanks are provided in Section 3 of the associated FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

All four Type IV tanks in the FTF (Tanks 17F through 20F) have been stabilized and operationally closed in accordance with the SRS FFA.

Figure 4.4-1: Typical Type IV Tank Cross-Section



4.4.1 Type IV Tank Primary Liner

Type IV tanks are 85 feet in diameter and approximately 34 feet high at the side wall with a nominal operating capacity of 1,300,000 gallons. [SRR-CWDA-2010-00128] The primary liner wall and floor are made of 0.375-inch thick carbon steel and the liner wall is reinforced internally by three circumferential 4- by 4-inch, L-shaped, carbon steel stiffener bands. The primary liner is anchored externally to the enclosing concrete vault wall. The primary liner floor is essentially flat with no sump, significant low points, or slope.

The Type IV tank roof is a self-supporting, hemispherical dome made of 7- to 10-inch thick concrete. The dome has an internal curvature radius of 90 feet 4 inches and a maximum rise of 10 feet 7.5 inches above the springline (Figure 4.4-1). The waste tank roof is not lined with carbon steel on the inside.

There is no secondary containment (secondary liner) or an annulus in the Type IV tanks.

4.4.2 Type IV Tank Concrete Vault

The Type IV primary liner is completely enclosed in a concrete vault built around the primary liner with the vault wall and the roof dome ring constructed using shotcrete and reinforcing bars. The core wall was constructed of shotcrete layers, which were allowed to harden three days between subsequent layer installations. The shotcrete walls were constructed in vertical strips to avoid any horizontal joints around the waste tank and the joints between vertical strips were staggered in subsequent layers. The shotcrete was applied in successive layers with thicknesses varying from 0.75 inches to a maximum of 2 inches. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

After the wall foundation and basemat had been set and cured, the space between them was filled with metallic, non-shrink grout with a compressive strength at least equal to that of the basemat. [W230976] The wall footing total width is 4 feet 10 inches, and extends 2 feet beneath the Type IV tank primary liner. The wall and wall footing contain vertical and horizontal reinforcing steel bars. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

A three-layer backfill system was emplaced around the outside of the concrete vault sidewall. Bags of vermiculite were placed in brick fashion on their long edges against the side of the vault to form a layer with an 8-inch minimum thickness. The bags are held in place by a retaining layer of special, manually compacted fill soil. The final test-controlled compacted fill was packed and rolled with heavy equipment to comply with moisture content and density specifications. The vermiculite fill provides a cushion layer for expansion and contraction of the primary liner resulting from temperature variations of the waste tank and contents. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

4.4.3 Type IV Tank Working Slab and Basemat

A 4-inch thick reinforced concrete slab covered with a 3-inch thick wire-mesh reinforced cement layer comprises a nominal 7-inch thick basemat for the Type IV tanks.

As part of a leak detection system, drainage channels (1.625 inches deep and 3.625 inches wide at the top and 3.125 inches wide at the bottom) were formed in the 3-inch thick cement topping-layer. The channels coincide with the locations of welds and backup strips on the primary liner floor. A 3-inch diameter stainless steel drainpipe to collect any leakage is located at the center of the basemat and it discharges to an 8-inch diameter by 8-inch long collection chamber below the footing at the edge of the waste tank wall. A 4-inch diameter pipe provides access to the sump from the surface for testing and sampling purposes (Figure 4.4-1).

4.4.4 Type IV Tank Support Columns

Type IV tanks do not have internal support columns.

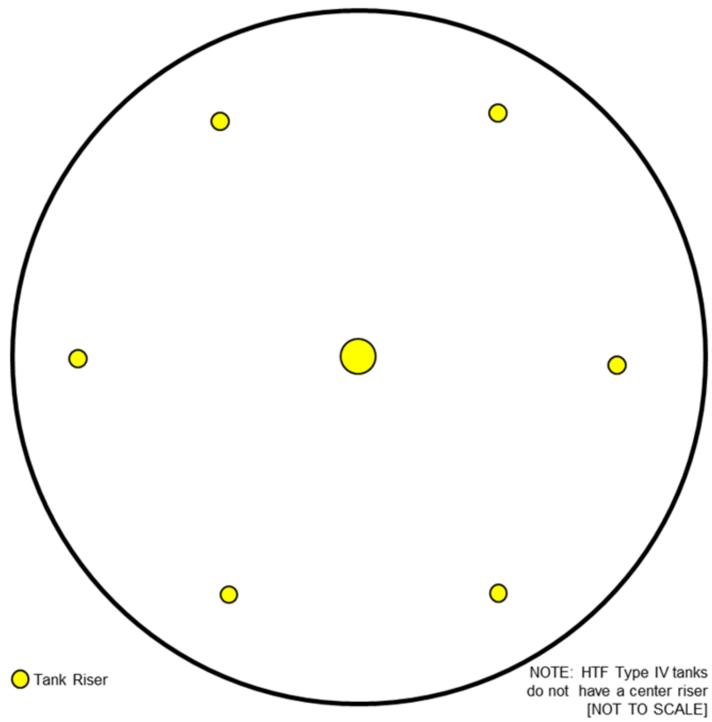
4.4.5 Type IV Tank Cooling Coils

Type IV tanks do not have cooling coils.

4.4.6 Type IV Tank Access and Riser Configuration

When viewed from above, the Type IV tanks have six 2-foot inside diameter primary liner access risers located at the 1, 3, 5, 7, 9, and 11 o'clock positions. The FTF Type IV tanks have an additional 10-foot inside diameter riser located in the center of the waste tank roof (Figure 4.4-2). [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Figure 4.4-2: Typical FTF Type IV Tank Access Riser Configuration



5.0 FACILITY DESCRIPTIONS

A legacy of the SRS mission was the generation of liquid waste from chemical separations processes in both F and H Areas. Since the beginning of SRS operations, an integrated waste management system consisting of several facilities designed for the overall processing of liquid waste has evolved. Two of the major components of this system are the FTF and HTF located in F and H Areas respectively, which are near the center of the site (Figure 5.1-1). The F- and H-Canyon facilities separated plutonium, neptunium, uranium, and other products from irradiated fuel and target assemblies using chemical separations processes. The tank farms, which store and process waste from the chemical separations processes, include waste tanks, evaporators, transfer line systems, and other ancillary structures.

5.1 FTF and HTF Descriptions

The FTF and HTF sites were chosen because of their favorable terrain and proximity to the F-Canyon Separations Facility (the major waste generation source for FTF) and the H-Canyon Separations Facility (the major waste generation source for HTF), which were located near the center of the Site, away from the SRS boundaries. The General Separations Area (GSA) is located atop a ridge running southwest to northeast that forms the drainage divide between two watersheds, the Upper Three Runs (UTR) to the north and Fourmile Branch (FMB) to the south. The GSA contains the F-Area and H-Area Separations Facilities, the S-Area Defense Waste Processing Facility (DWPF), the Z-Area Saltstone Facility, the E-Area Low-Level Waste Disposal Facilities, and the J-Area SWPF, which completed construction on April 22, 2016. Figure 5.1-2 shows the location of F Area, FTF, H Area, and HTF within the GSA.

The FTF and HTF were constructed to receive waste generated by various SRS production, processing, and laboratory facilities. The use of FTF and HTF isolated these wastes from the environment, SRS workers, and the public. With FTF and HTF, facilities are in place to pretreat the accumulated sludge and salt solutions (supernate) to enable the management of these wastes within other SRS facilities such as the DWPF and Saltstone Production Facility (SPF). These treatment facilities convert the sludge and supernate to more stable forms suitable for permanent disposal in a federal repository or the Saltstone Disposal Facility (SDF), as appropriate. The Effluent Treatment Project (ETP), located southeast of the HTF, collects and treats wastewater and evaporator overheads from FTF and HTF operations. Extensive descriptions of the FTF and HTF waste processing facilities are provided in the associated FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

The FTF is a 22-acre site consisting of 22 waste tanks, two evaporator systems, six diversion boxes (DBs), one catch tank, a concentrate transfer system (CTS) tank, three pump pits (PPs), one CTS PP, and over 45,000 feet of transfer pipelines (Figure 5.1-3). The HTF is a 45-acre site consisting of 29 waste tanks, three evaporator systems, eight DBs, one catch tank, 10 PPs (each has one pump tank except HPP-1 which has none), two CTS PPs, approximately 74,800 feet of transfer pipelines, and three control rooms (Figure 5.1-4).

As described in Section 4, there are three of the four waste tank design types in FTF and all four waste tank design types in HTF. The tanks range in size from 750,000 gallons to 1.3 million gallons and have varying degrees of secondary containment and intra-tank interferences, such as cooling coils and roof support columns. The waste tank system design features (e.g., waste tanks, transfer lines, evaporator systems) are discussed in more detail in Section 3 of the associated FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Figure 5.1-1: SRS Operational Area Location Map

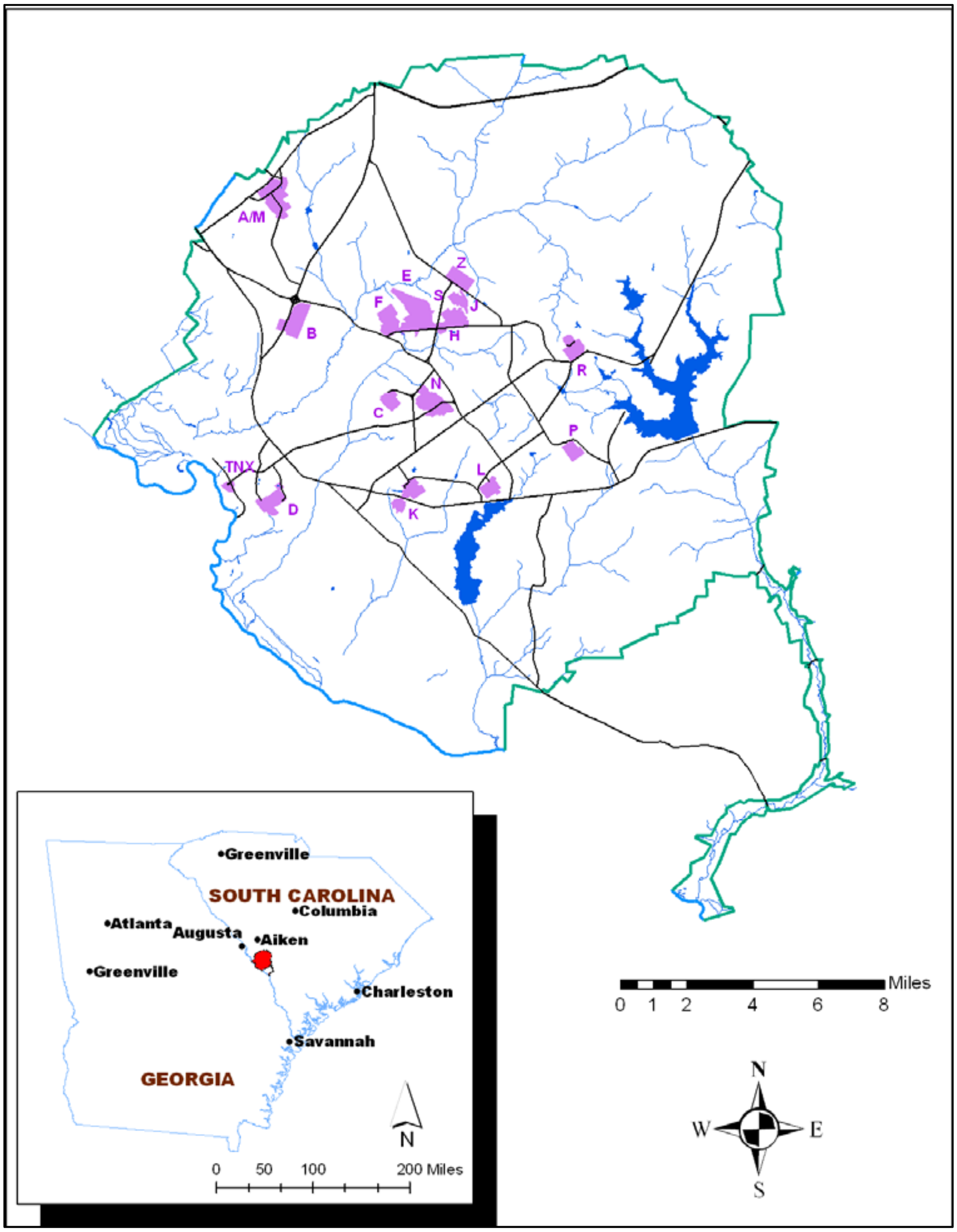


Figure 5.1-2: Layout of the General Separations Area

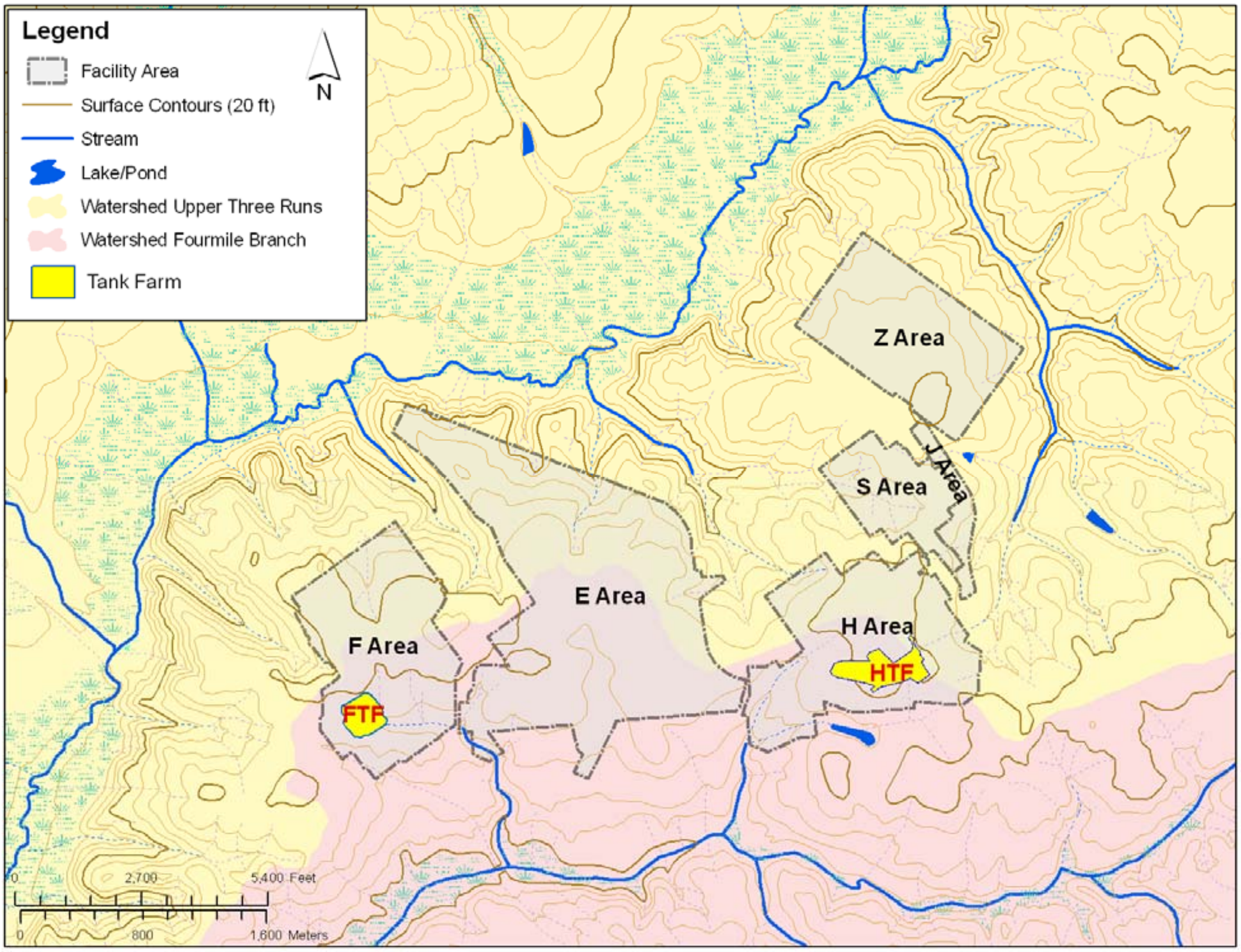


Figure 5.1-3: Layout of the F-Area Tank Farm

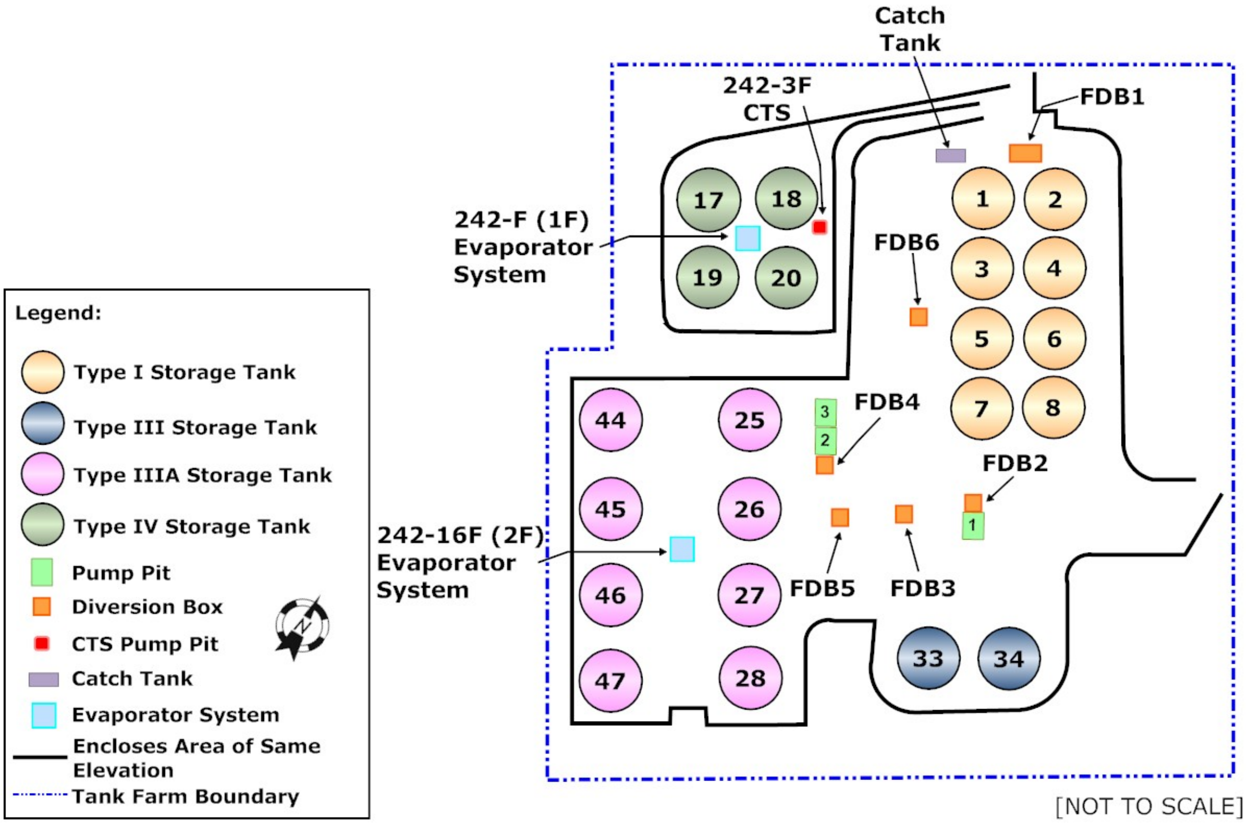
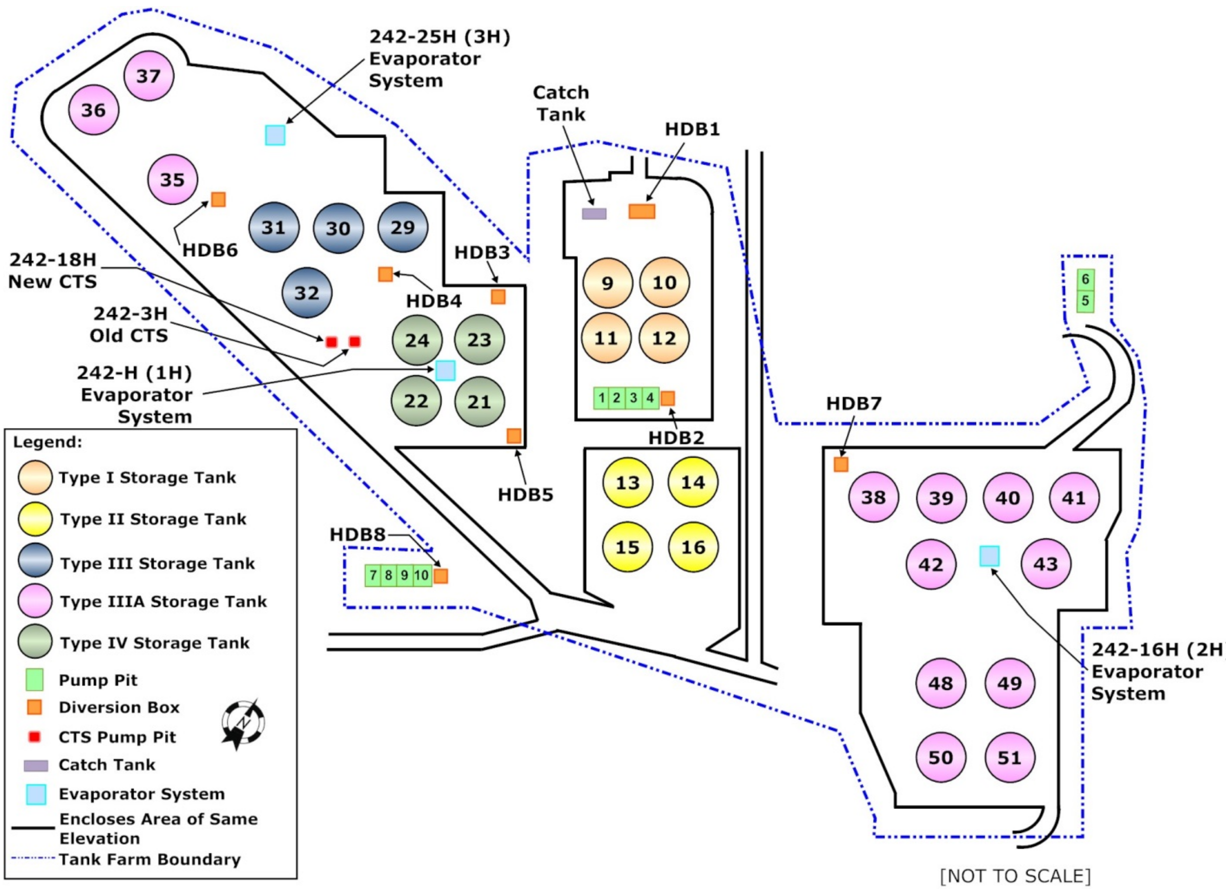


Figure 5.1-4: Layout of the H-Area Tank Farm



5.2 H-Area Tank Farm Salt Waste Pretreatment

The ARP and MCU salt waste pretreatment facilities are currently located within the footprint of the HTF to reduce the radioactivity in the salt waste and prepare it for stabilization and disposal at the saltstone facilities. The ARP and MCU work together as an integrated system to remove nearly all of the high-activity radioactive isotopes from salt waste solutions prior to its transfer to the SPF and SDF along with the waste tank sludge. The removed high-activity radionuclides are sent to the DWPF. The goal is to immobilize all of the tank farm waste into one of two final forms for safe, long-term storage: glass, which will contain approximately 99 percent of the radioactivity, and cement-like grout, which will contain very little radioactivity, but most of the volume. The combination of ARP and MCU provides the capability to reclaim space in the FTF and HTF for salt dissolution activities. By reducing the soluble strontium, actinide, and cesium concentrations, salt solutions can be stabilized at the SPF and disposed at the SDF.

At the start of the ARP process, monosodium titanate (MST) is added to radioactive salt solutions and soluble radioactive contaminants, such as plutonium and strontium, are absorbed onto the MST molecules. When the treated solution is passed through ARP, the MST-radionuclide particles and other insoluble solids are filtered out. MST additions are performed as long as tank space operation margin objectives can be met and sustained. However, if due to emergent technical or processing issues, the tank space objectives cannot be met prior to SWPF start-up, and the soluble actinides in the original salt solution are below Class C concentration limits, MST will not be added and the waste stream will only be filtered before transfer to MCU.

The waste particles filtered out of the salt solution are transferred to the DWPF where they are mixed with molten glass and poured into 10-foot tall stainless steel canisters that are then welded shut and temporarily stored on-site awaiting final disposition at an off-site Federal repository. The remaining filtered salt solution is then sent to the MCU for further processing.

Using principles involving centrifugal force and a special engineered solvent, MCU equipment takes the high activity salt solution and divides it into two waste streams. The cesium is removed and sent to the DWPF. The remaining decontaminated salt waste solution is transferred to the SPF to be mixed with dry cement-like materials to form a grout for safe, permanent on-site disposal in engineered disposal units. Caustic-Side Solvent Extraction (CSSX) is the selected technology for removing cesium from the liquid waste. The CSSX process utilizes centrifugal contactors to contact the waste solution with a unique solvent matrix which removes the cesium. The cesium is then stripped from the solvent and concentrated in an aqueous effluent stream which is treated at the DWPF where it is combined with sludge and vitrified. The decontaminated solvent is then recycled in the process. [CBU-SPT-2005-00143] ARP/MCU treatment will be replaced by the SWPF when this facility begins operation. Construction of the SWPF was completed on April 22, 2016 and the testing and commissioning phase has begun.

5.3 Ancillary Structures

The FTF and HTF both contain ancillary structures with internal equipment having a residual contaminant inventory that must be accounted for as a part of facility closure. These ancillary structures and equipment include buried transfer lines, pump tanks, and evaporators, many of which have been in contact with liquid waste during the operating life of the facilities. The ancillary equipment was used in the FTF and HTF to transfer waste (e.g., transfer lines, pump tanks) and reduce waste volume though evaporation (e.g., the evaporator systems). The amount of contamination associated with these components depends on such factors as the component service life, its materials of construction, and the contaminating medium in contact with the component.

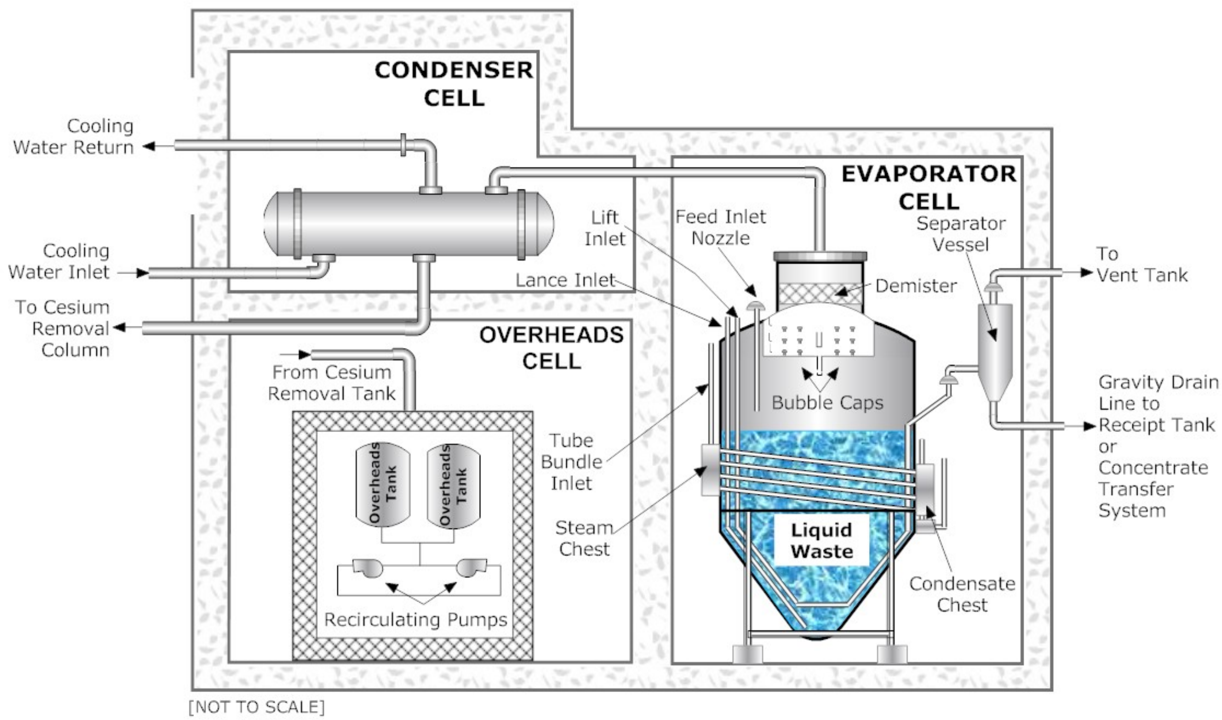
5.3.1 Evaporator Systems

There are two evaporator systems in the FTF and three evaporator systems in the HTF. The systems in FTF are the 242-F evaporator system (1F Evaporator) and the 242-16F evaporator system (2F Evaporator). The systems in HTF are the 242-H evaporator system (1H Evaporator), the 242-16H evaporator system (2H Evaporator), and the 242-25H evaporator system (3H Evaporator). The 1F and 1H evaporators have the same mechanical structure. The 2F and 2H evaporators have the same mechanical structure. The evaporators are used to reduce the amount of liquid resulting from nuclear material processing. The evaporator systems are principally comprised of the evaporator, the overheads system, and the condenser. The 242-F and 242-H evaporator systems also include the CTS, which was used to distribute evaporator concentrate throughout the respective tank farm. None of the CTS systems are in operation. They will be operationally closed in the future.

5.3.1.1 242-F and 242-H Evaporator Systems

The 242-F evaporator is located in the middle of the Tank 17-20 cluster in the FTF; it began supernate evaporation in 1960 and ceased operation in 1988. The 242-H evaporator is located in the middle of the Tank 21H-24H cluster in the HTF; it began supernate evaporation in 1963 and ceased operation in 1994 due to a failed tube bundle. The evaporator cell in each system is a cuboid with a 16- by 15-foot base and a height of 25 feet. The cell includes a 2-foot square, 2.5-foot deep floor sump. The cell covers are 1-foot thick reinforced concrete. The cell provided containment for the evaporator and served as shielding for personnel protection. Figure 5.3-1 shows the design of the 242-F and 242-H evaporator systems. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Figure 5.3-1: 242-F and 242-H Evaporator System Design

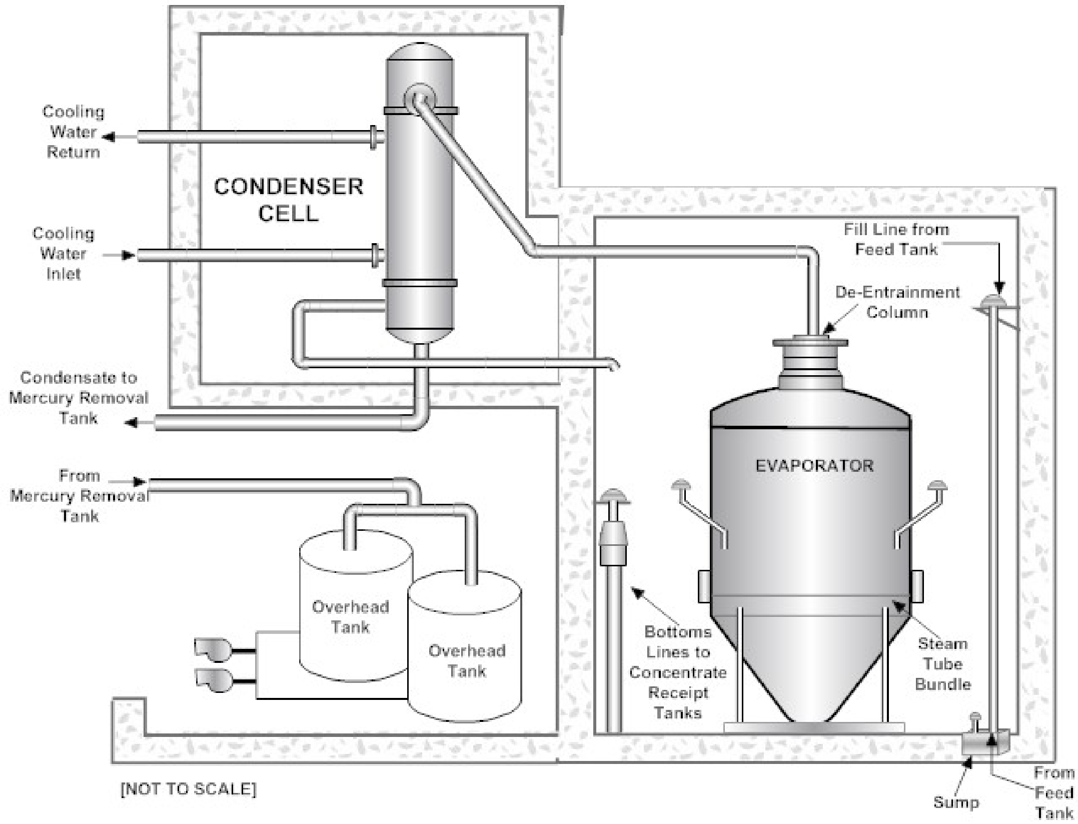


Note: Jumpers from the evaporator pot to the receipt tanks and from the feed tank to the condenser were not included to minimize the complexity of the figure.

5.3.1.2 242-16F and 242-16H Evaporator Systems

The 242-16F and 242-16H evaporator systems each contain three cells and a gang valve house. The evaporator cell contains the evaporator vessel (pot); the condenser cell contains the condenser; and an overheads cell contains overheads system components other than the condenser as shown in Figure 5.3-2. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Figure 5.3-2: 242-16F and 242-16H Evaporator System Design

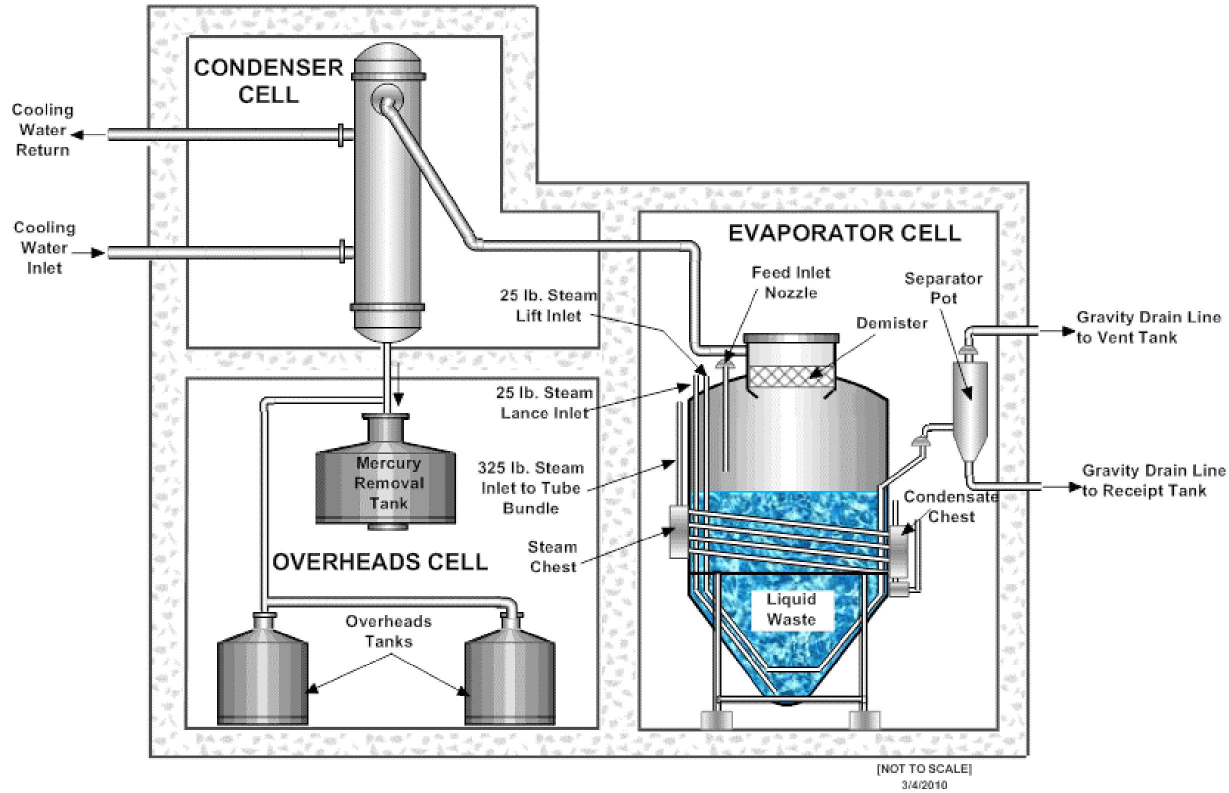


Note: Jumpers from the evaporator pot to the receipt tanks and from the feed tank to the condenser were not included to minimize the complexity of the figure.

*5.3.1.3 **242-25H Evaporator System***

The 242-25H evaporator facility includes the evaporator cell, which houses the evaporator vessel (pot), the condenser cell and condenser, and an overheads cell, which contains the overheads system (that includes the mercury removal tank, mercury removal station, two overheads tanks, and two overhead pumps). Figure 5.3-3 shows the design of the 242-25H evaporator system. [SRR-CWDA-2010-00128]

Figure 5.3-3: 242-25H Evaporator System Design



Note: Jumpers from the evaporator pot to the receipt tanks and from the feed tank to the condenser were not included to minimize the complexity of the figure.

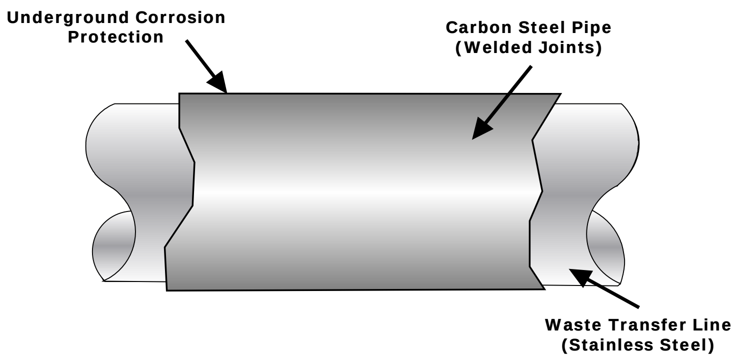
5.3.2 Transfer Line Systems

There are over 45,000 feet of transfer line piping in FTF, with segments ranging from a few feet to over 4,000 feet. The HTF has approximately 74,800 feet of transfer line with segments ranging from a few feet to almost 3,400 feet in length. The FTF and HTF waste transfer lines are typically constructed of a stainless steel primary core pipe and are generally located below ground. Those lines that are above, or near, the surface are shielded to minimize radiation exposure to personnel. Most of the primary transfer lines in FTF and all of the primary transfer lines in HTF have secondary containments of some type. The majority of primary transfer lines are enclosed within another pipe (jacket) constructed of carbon steel, stainless steel, or cement-asbestos. These jackets typically drain to leak detection boxes (LDBs), modified LDBs (MLDBs), or to another primary or secondary containment vessel (e.g., a waste tank). The balance of the primary transfer lines are located inside covered, concrete encasements (covered troughs), that function as the secondary containment.

Multiple (core) waste transfer lines may be contained in a single secondary containment jacket or concrete encasement. Waste transfer lines are typically sloped to be self-draining and where a pipe transitions from one size to another, the bottom of the pipe is generally aligned to facilitate drainage to the intended waste tank without holding back any material.

The line segments are supported using rod or disk-type core pipe spacers, core pipe supports, jacket supports, jacket guides, or other approved methods. Typically, core pipe spacers and supports are of stainless steel welded to the core pipe and jacket, while jacket supports and guides are of stainless steel with a concrete support. A typical transfer line is depicted in Figure 5.3-4. Additional transfer line details are provided in Section 3 of the associated FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Figure 5.3-4: Typical Transfer Line Design



5.3.3 Leak Detection Boxes and Modified Leak Detection Boxes

The LDBs provide for the collection and detection of leakage from a transfer line. LDBs are located at the low point of the transfer line being monitored, and any leakage from the line will gravity drain via drain piping from the transfer line jacket to an LDB. The LDBs have automatic conductivity probe leak detection, a dip tube set (pneumatic level instrumentation tubes) for manual verification of leaks, and overflow and drain lines to empty the LDB if necessary. The drain and overflow lines are typically kept plugged to allow leakage collection for detection by the conductivity probe. The LDB drain piping runs to the evaporator cell sump, or to a DB, PP, or drain cell. A typical LDB is shown in Figure 5.3-5.

The MLDBs serve the same purpose as the LDBs but are larger and are installed at low points that cannot gravity drain to a collection point. In addition to a conductivity probe, MLDBs also include a vent line to a DB or PP, an above-ground pressure gage to indicate if the diversion box is plugged or full, and a smear/cleanout pipe for measuring level and manual pump-out of collected leakage into the box. [SRS-REG-2007-00002, SRR-CWDA-2010-00128] A typical MLDB is shown in Figure 5.3-6.

Figure 5.3-5: Typical Leak Detection Box

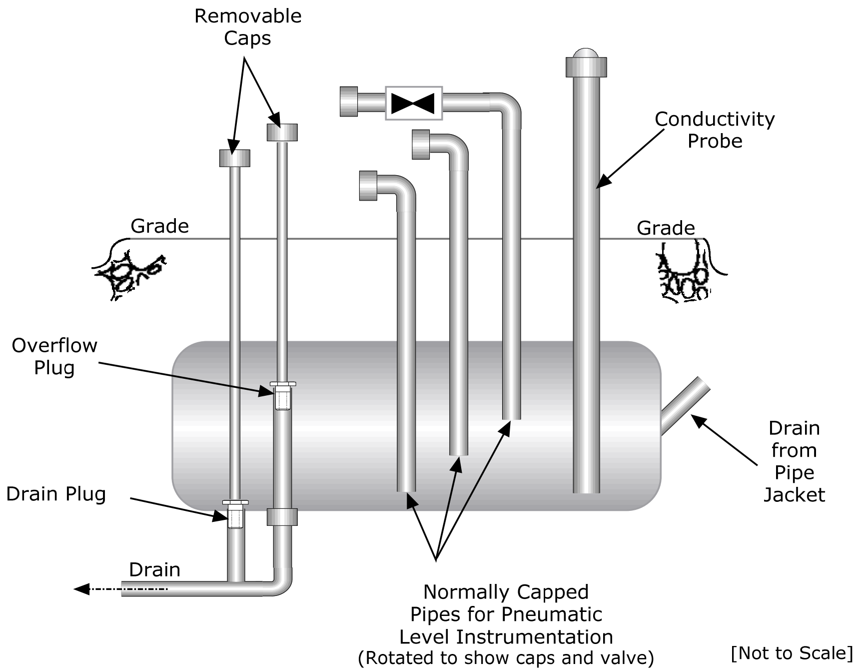
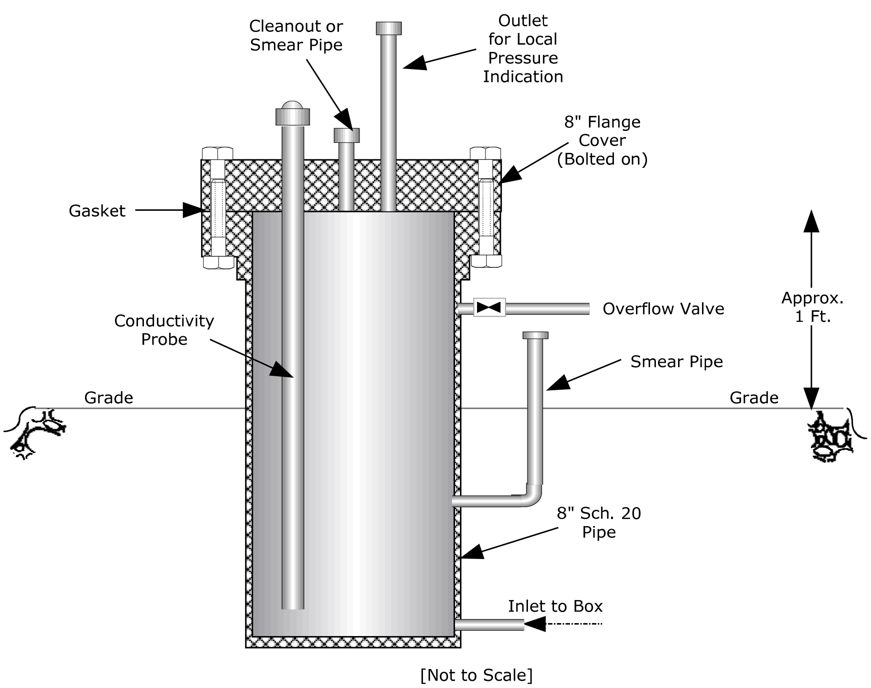


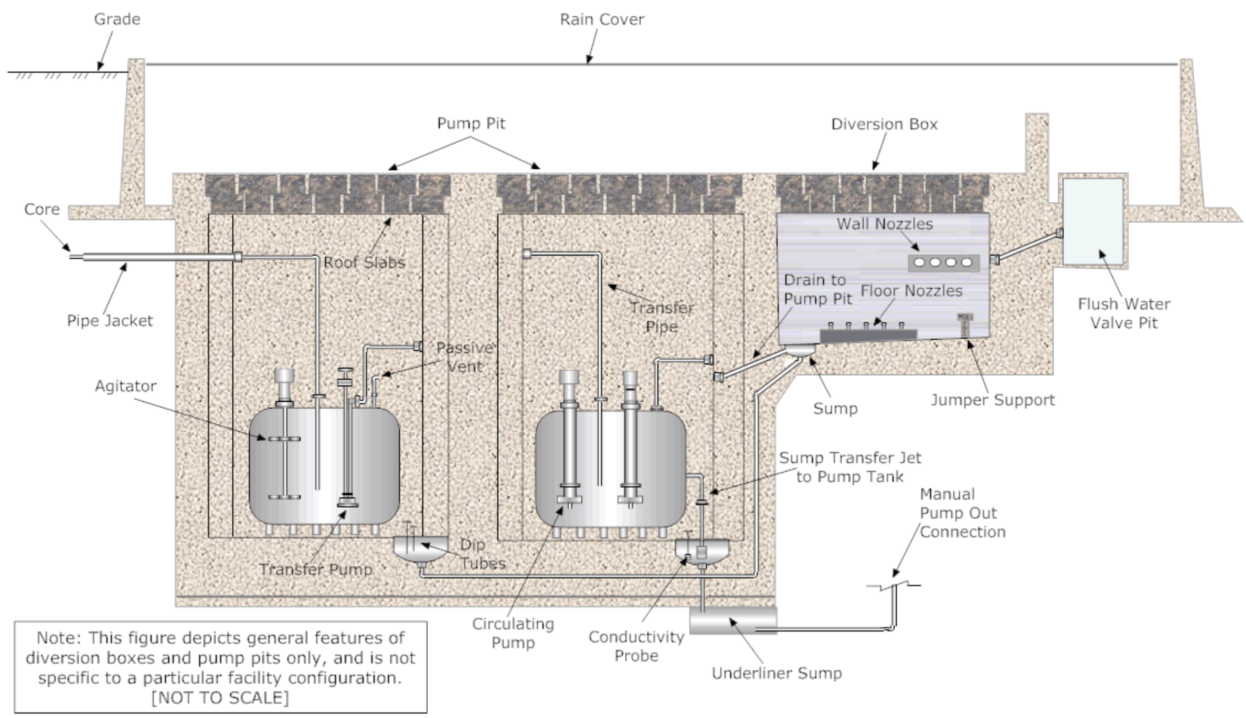
Figure 5.3-6: Typical Modified Leak Detection Box



5.3.4 Pump Pits and Pump Tanks

The FTF has three PPs (FPP-1 through FPP-3) and one CTS PP (242-3F), and the HTF has 10 PPs (HPP-1 through HPP-10) and two CTS PPs (242-3H and 242-18H). The PPs are reinforced concrete structures (usually lined with stainless steel) and are located below grade at the low points of the transfer lines. The PPs typically have walls that are a minimum of 2 feet, to at least 3 feet thick with sloped floors that are approximately 3 feet thick and concrete cell covers that are a minimum of 1-foot 4 inches, to 3 feet thick. All PPs house a pump tank (with the exception of HPP-1) and provide secondary containment for the pump tanks. Figure 5.3-7 shows a typical DB and PP design. Additional details of the PPs and pump tanks are provided in Section 3 of the associated FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Figure 5-3.7: Typical Diversion Box and Pump Pit



5.3.5 Diversion Boxes and Valve Boxes

The FTF contains six DBs (FDB-1 through FDB-6) and the HTF contains eight DBs (HDB-1 through HDB-8). The DBs are reinforced concrete structures that provide a central location for waste transfer lines. The DBs contain transfer line nozzles to which jumpers are connected to direct waste transfers to the desired waste tanks and pump tanks. This reduces the number of transfer lines necessary to perform transfers among tanks and other facilities. Each of the DBs is associated with, and provides connections to, a group of waste tanks. The DBs are often constructed in conjunction with a PP. In HTF, two of the DBs are incorporated with HPP-1 through HPP-4 and HDB-8 is incorporated with HPP-7 through HPP-10. Additional DB details are provided in Section 3 of the associated FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Valve boxes provide passive containment for valve manifolds used to transfer waste using common transfer lines to support facility operations. Valve boxes house permanently installed valve manifolds within a heavily-shielded box constructed of stainless steel. Valve boxes are generally located adjacent to the waste tanks to allow transfers to be isolated as necessary.

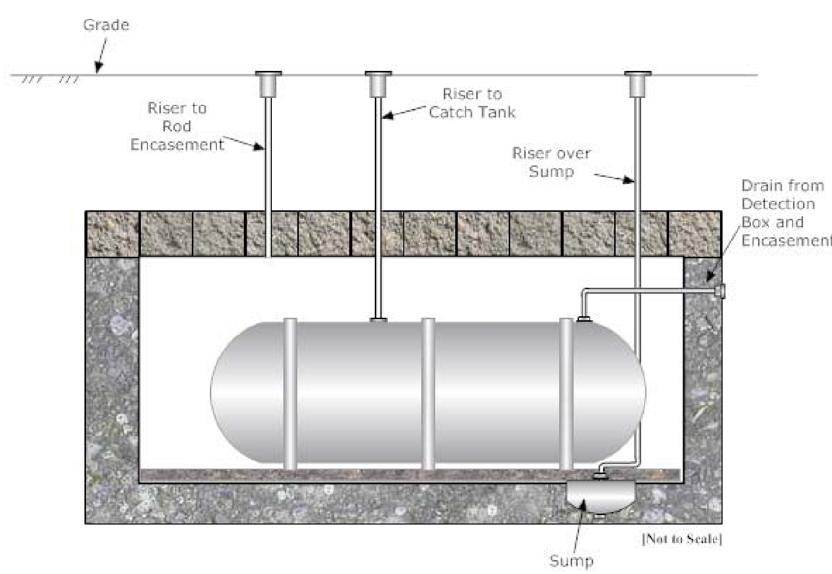
All valve boxes contain conductivity probes that actuate control room alarms if leakage is detected. Leakage that collects in the valve box will generally drain to the associated waste tank, DB, or LDB. The valve boxes specific to each farm are described in Section 3 of the associated FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

5.3.6 Catch Tanks

There is a single catch tank in FTF designed to collect drainage from FTF DB-1 and the covered concrete troughs (encasements) containing the Type I tank transfer lines. Likewise, there is a single catch tank in HTF designed to collect drainage from HTF DB-1 and the Type I tank transfer line encasements. Figure 5.3-8 shows a typical catch tank.

Each stainless steel catch tank has concave ends, a straight shell length of 30 feet, a diameter of 8 feet, and a capacity of approximately 11,700 gallons. Each catch tank is located in an underground reinforced concrete cell that rests on a 4-inch thick concrete construction slab. Each cell has walls that are 2 feet 6 inches thick, a roof (cover) that is 2 feet 4 inches thick, and floor that is approximately 3 feet 1.5 inches thick. The floor surface is sloped towards a floor sump that is 2 feet wide by 1-foot long and 1-foot deep that can be emptied through a surface riser. [W146075, SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Figure 5.3-8: Typical Catch Tank



5.3.7 Filter/Stripper Building, 241-96H

Building 241-96H in the HTF is an existing filter/stripper building in HTF formerly used for the Interim Treatment Process (ITP). The northern portion of the building, referred to as the stripper building, has been partially closed. [DHEC_12-06-2006] The southern portion, referred to as the filter building, has been modified to include enhanced equipment for the ARP which is subject to Construction Permit #19,169-IW. [DHEC_01-15-2008] The remaining building structure, which does not contain any equipment, is subject to Construction Permit #17,424-IW.

6.0 WASTE REMOVAL METHODOLOGY

Although the waste tank system removal effort intends to remove or decontaminate all residues, contaminated containment system components (liners, etc.), and structures contaminated with hazardous and/or radioactive substances, it is recognized that DOE cannot practicably remove or decontaminate all structures and equipment. [WSRC-OS-94-42 Section IX.E.2] Consequently, the general strategy for waste tank systems closure, which begins with prioritization of waste tanks to be removed from service, focuses on the general methods for decontamination technology selection and implementation.

The order of removal from service of the waste tank systems is driven by a series of priorities and operating constraints that includes, but is not limited to, the following:

- Maintaining contingency waste tank space within the entire liquid waste system (i.e., space available in both FTF and HTF waste tanks),
- Controlling waste tank chemistry to maintain the integrity of the carbon steel primary tank liners,
- Requirements to remove waste from waste tanks with a leakage history and tanks that do not meet secondary containment and leak detection requirements on a schedule specified in the FFA Appendix L,
- Restrictions imposed by state-approved permits (Construction Permit #17,424-IW, and SRS Z-Area SDF Class 3 Landfill Permit #025500-1603, [DHEC_01-25-1993, DHEC_09-09-2008]
- Commitments in the *Savannah River Site Approved Site Treatment Plan, 2011 Annual Update*, (SRNS-TR-2008-00101)
- Preparing waste for downstream waste treatment facilities (e.g., DWPF, ARP/MCU, SWPF, SPF, etc.),
- Meeting nuclear safety basis requirements.

The complex interdependency of safety and process requirements of the various waste pretreatment facilities, as well as the limited available space within the waste tank systems, influences the sequencing of the waste tanks undergoing waste removal and cleaning. The ancillary structures, such as evaporator systems and CTS, may be closed independently or as part of the closure of an individual waste tank or a group of waste tanks. DOE will determine the most efficient and cost-effective schedule for removal from service of these ancillary structures and will continue to communicate the plans and schedules for these closure activities with SCDHEC. The ancillary structure removals from service will also be tracked via the system-specific CMs as described in Section 11.

Several Type I and Type II waste tanks are known to have leaked into their annular space. Waste removal from the annular space is potentially problematic for two reasons:

1. If primary tank waste removal leaves insufficient ballast inside the primary tank, buoyancy could destabilize the primary tank when liquid is added for annulus waste removal.

2. If waste inside the primary tank is not removed prior to the annular space cleaning, additional waste could leak into the annular space when liquid is added to the primary tank.

For those waste tanks where the waste has leaked into the annular space, an alternative closure sequence may be needed, such as partial stabilization of the primary tank prior to annular space waste removal. If an alternative is required, DOE will seek concurrence with SCDHEC and EPA on an alternate closure sequence on a case-by-case basis in conjunction with the process to cease waste removal activities as discussed in Section 6.3.

DOE's anticipated schedule for waste tank systems removal from service was developed in accordance with federal and state agreements. The FFA established commitments and milestones for removal from service of Type I, Type II, and Type IV tanks (i.e., waste tanks that do not meet the standards set forth in Appendix B of the FFA). [WSRC-OS-94-42] As described in the *Savannah River Site Approved Site Treatment Plan, 2011 Annual Update* (SRNS-TR-2008-00101), Type III and Type IIIA tanks will remain in service until they are no longer needed to support waste treatment efforts.

6.1 Process for Waste Removal Technology Selection

The actual process used for waste removal can vary depending on the past service history of the waste tank system, the physical characteristics of the remaining waste, the physical configuration of the waste tank system, and the timing of the waste removal actions. Similar waste tanks may be evaluated as a group, rather than individually, when a waste removal technology is selected.

In the waste removal technology selection process, DOE uses a structured approach (e.g., Alternative Studies method) for identification and comparison of viable alternatives that meet the defined functions and requirements for waste removal in the specific application. The Alternative Studies method is an example of a technology selection process that has been used successfully at SRS. [WSRC-IM-98-00033] The Alternatives Studies method uses formal analysis and is based on a set of weighted decision criteria. A sensitivity analysis may be included to aid in selection of a preferred alternative.

The DOE's technology selection process generally follows the Alternative Studies methodology (with modifications where appropriate) and typically includes activities similar to the following steps:

1. Identification and selection of a group of individuals with the necessary skills and experience in waste tank system operations to effectively identify and assess viability of waste removal options.
2. Identification of the function(s) to be met and the defined project requirements - Criteria for technology include a reasonable likelihood of achieving estimated removal results.
3. Identification of alternatives which perform the function(s) - A wide range of current technologies are considered (e.g., sluicing, mixing, chemical, vacuum, manipulators, and robotics) from DOE, commercial, and international sources. Alternatives include volume reduction and chemical extraction technologies.

4. Determination of the alternatives' viability to satisfy requirements - Selection of viable alternatives that have a reasonable likelihood of success based on similar applications within DOE and/or industry are considered. Proof-of-principle demonstrations and laboratory or pilot-scale tests may be used to aid in the determination of viability.
5. Establishment and weighting of criteria to evaluate alternatives against - Criteria may include likelihood to effectively meet desired waste removal results (functions and requirements), maturity, cost, complexity, reusability, radiological control requirements, and system-wide impacts (effects on downstream systems, generation of secondary waste, etc.).
6. Evaluation of alternatives against the selected criteria - Each alternative is evaluated against each criterion and assigned a comparative ranking.
7. Selection of a preferred alternative - A scoring method is used for selecting a preferred alternative. In the scoring method, the merit of each alternative is determined by summing the contributions to that alternative from each identified criterion. In this method, weighted criteria must be used if the criteria have varying degrees of importance. In the scoring method of alternative selection, defined and weighted criteria are used to select the optimum from among a set of alternatives that meet the defined function.

DOE will continue to evaluate new technologies as they are developed for potential use in waste removal applications. In addition, they will also evaluate, on a case-by-case basis, any special conditions that may occur during waste removal activities that may require application of additional or alternative technologies. DOE will share these evaluations on a waste tank-specific basis with SCDHEC at the earliest practical quarterly meeting.

6.2 Potential Future Waste Tank Cleaning Technology

DOE's process for considering technological developments relevant to waste tank system cleaning that occur after issuance of this CGCP will include the evaluation of techniques of comparable, or greater, effectiveness than the technologies currently in use. A range of potential technologies for evaluation will include technologies developed and/or used at other DOE sites, in domestic commercial industry, and in international applications. Waste tank system cleaning technologies that will potentially be evaluated include, but are not necessarily limited to, sluicing, mixing, chemical cleaning, vacuum retrieval techniques, mechanical manipulators, robotic devices, and processes that target removal (chemical extraction) of certain material from the residuals that may remain in the waste tank. The technology selection process described in Section 6.1 will be used to evaluate future technologies.

The FFA Appendix L, Requirement 9.b states:

> *9.b "The Parties agree to the following process concerning waste removal. For each tank, DOE shall involve SCDHEC and EPA throughout each stage of the bulk waste and heel removal processes to explain the activities undertaken, results of removal operations, challenges, and DOE's next steps. DOE shall consider and openly discuss any feedback from participants prior to proceeding to the next stage. These interactions are anticipated to be frequent and informal meetings or conference calls as agreed to by the participating parties but shall occur no less than quarterly. When DOE considers*

> *waste removal to be complete, DOE shall notify EPA and SCDHEC and provide any supporting documentation to SCDHEC and EPA for review. DOE, SCDHEC and EPA shall mutually agree that waste removal activities may cease."*
> [WSRC-OS-94-42, Appendix L]

DOE provides annual updates on new waste removal and characterization technologies to SCDHEC in a dedicated meeting as information becomes available. Materials presented in these annual meetings are provided to SCDHEC in a manner that can be referenced. These annual updates include sharing of information and lessons learned between DOE sites and recent and regular reports published under DOE's technology development program.

6.3 Cessation of Waste Removal Activities

A dispute resolution was reached between DOE, EPA, and SCDHEC in November 2007 concerning the extension of removal from service dates in the FFA for Tanks 18 and 19. This dispute resolution has been incorporated into the FFA in Appendix L. [WSRC-OS-94-42] One of the conditions in the FFA, Appendix L requirements, as stated above, is that all three parties agree that waste removal activities may cease.

This decision process occurs in two phases. Once DOE has reached the conclusion that there is reasonable assurance that waste removal activities for a particular waste tank system can cease, DOE provides preliminary data and other information that waste has been adequately removed using the selected technology and that there is reasonable assurance that compliance with performance objectives can be demonstrated. The preliminary data provided to SCDHEC and EPA varies depending on the waste tank and its history. Examples of this information include evidence of diminished effectiveness of technology used on waste removal demonstrated by charts, graphs, photographs, videos, available process sample analysis, and technical papers. The ultimate outcome is a mutual agreement between DOE, SCDHEC, and EPA that it is not technically practicable, from an engineering perspective, to continue waste removal activities. DOE would then proceed to the sampling and analysis phase of the waste tank system removal from service process. [WSRC-OS-94-42]

This tentative agreement to cease waste removal activities is documented in letters of agreement to DOE from SCDHEC and from EPA. This preliminary decision to move on to the sampling and analysis phase is non-binding and does not satisfy Appendix L, Requirement 9.b.

Subsequently, a full review of the final residuals characterization and configuration is made available in the CM which must be approved by SCDHEC before stabilization can be initiated. The DOE will make no irreversible configuration changes to the waste tanks until the CM has been submitted and approved by SCDHEC. After SCDHEC formal approval of the CM, EPA and SCDHEC will provide a final letter of agreement that waste removal activities may cease. EPA's and SCDHEC's agreement letters satisfy Appendix L, Requirement 9.b. The approval process is depicted in Figure 11.4-1.

7.0 WASTE REMOVAL TECHNOLOGY AND DEPLOYMENT

Between 1966 and 1969, initial sludge removal from seven waste tanks (1F, 2F, 3F, 9H, 10H, 11H, and 14H) in the FTF and HTF was performed using high-velocity water jets. The waste consolidation allowed five of these seven tanks to be subsequently used as evaporator concentrate receipt tanks. [HLW-STE-98-0218] The drawbacks to using these types of jets were the large water volumes required to slurry the sludge (approximately five times the volume of sludge removed) and the high operating pressure needed (approximately 3,000 psi). Additionally, the high-pressure, positive-displacement pumps used to operate these jets were not designed to be operated and maintained in the high radiation environment present inside a waste tank. Later studies showed that using a low-pressure, single-stage centrifugal pump for recirculation was feasible for mobilizing sludge waste. In 1977, a new waste tank cleaning technology was developed by Savannah River National Laboratory (SRNL) that used supernate for low-pressure, sludge-slurrying and eliminated the need for water addition.

7.1 Mechanical Sludge Removal (MSR)

Bulk sludge waste is typically removed from tanks using mechanical systems for mixing, pumping, and transfer. The same pumps and equipment may also be used later when the tank undergoes removal of the remaining sludge heel. Pump types used in previous waste removal campaigns or planned for use in upcoming campaigns are described below. Pump availability, design advances, waste type, waste rheology, and other tank-specific characteristics will determine the actual pump type(s) selected and used in future waste removal efforts. Additional information on previous waste removals, technology selection, and lessons learned can be found in *SRR Waste Removal and Operational Closure Strategy* (SRR-CWDA-2014-00003) and *Optimization of Sludge Waste Removal Flowsheet at SRS through Incorporation of Testing and In-Tank Waste Experience* (SRR-LWE-2014-00168). The parameters for the mixing pumps typically used during MSR are summarized in Table 7.1-1 and pump use details are discussed in the following sections.

Table 7.1-1: Summary of Mechanical Waste Removal Pump Parameters

Pump Type	Pump Cooling	Approximate Minimum Liquid Level for Operation (inches)	Operating Mode		Approximate Effective Cleaning Radius (feet)
			Oscillating	Indexed	
Slurry Pump (SLP)	Water Addition	21 - 30	360º	Yes	24 - 26
Submersible Mixing Pump (SMP)	Product drawn through pump	44	210º	Yes	52
Advanced Design Mixing Pump (ADMP)	Product drawn through pump	42	360º	Yes	52
Commercial Submersible Mixing Pump (CSMP)	Product surrounding pump	24 - 30	210º	Yes	29

SRR-CWDA-2014-00003
SRR-STI-2014-00571

7.1.1 Slurry Pump (SLP)

SLPs are used to mix the bulk waste and sludge heel for removal by submersible transfer pumps (STPs). These pumps produce liquid jets by drawing tank liquid and suspended sludge into the bottom of the pump and forcing it out through two oppositely directed nozzles. The liquid jets have a sludge-slurrying capability equal to the previously used high-velocity jet system. [DP-1468] Figure 7.1-1 shows a typical SLP design.

The first SLPs were designed to fit in a 24-inch diameter waste tank riser. In 1977, pump testing was done using a full-scale tank floor diameter mockup at the SRS Training and Experimental Test Facility (TNX). This mockup consisted of a horizontal cooling coil array and six roof-support columns simulating an actual Type I waste tank floor. The testing used water to simulate supernate and kaolin clay to simulate the radioactive sludge. The SLP cleaning pattern was evaluated using the thickness and location of the kaolin clay remaining on the mockup floor after the slurried simulant was removed. The slurrying ability of the SLP was termed the effective cleaning radius (ECR), and defined as the radial distance from the center of the pump impeller to the point on the mockup floor having a residual layer of kaolin less than one-eighth of an inch thick after the testing. The ECR of the SLP was approximately 24-26 feet. [SRR-CWDA-2014-00003] Early SLPs had a 2,000-hour operational life span, but newer designs increased the life expectation to 8,000 hours.

The SLPs can be operated in two modes, oscillatory and indexing. During oscillatory runs, the spray nozzles are rotated through 360 degrees using a turntable assembly to create a circular cleaning pattern. The turntable is driven by a 0.5 horsepower reversible motor equipped with a variable speed pulley for adjusting the turntable speed from 0.2 to 0.5 rpm. Testing of the prototype SLP at the TNX facility using the clay sludge simulant showed that periodic reversal of the rotation direction significantly improved clay removal behind the obstacles on the mockup tank floor. [DPSTD-241-TK-16H] In indexing mode, a specific location in the waste tank is targeted. The pump turntable assembly in Figure 7.1-2 is shown set to a fixed position which also fixes the direction of the pump discharge spray.

Figure 7.1-1: Slurry Pump and Motor Arrangement

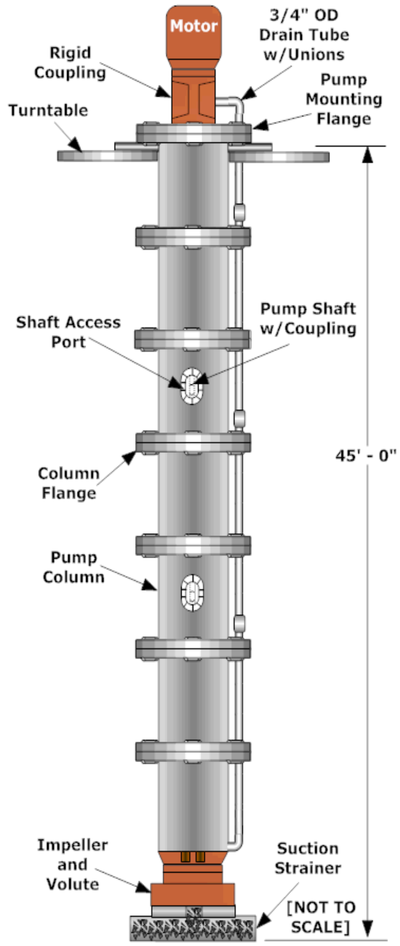
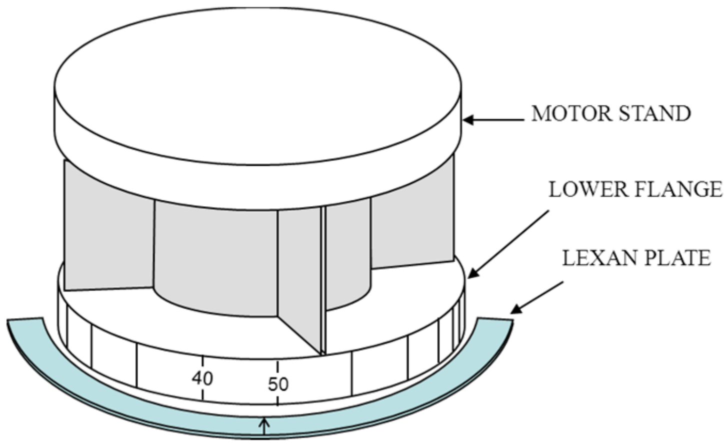


Figure 7.1-2: Slurry Pump Turntable



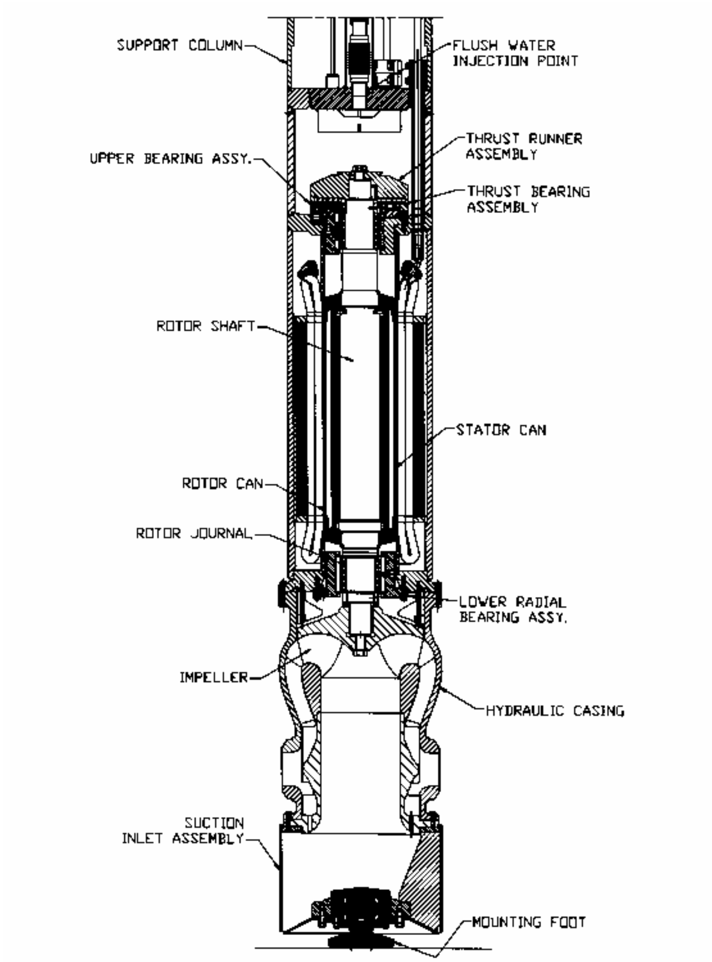
Note: The pump index is shown set to the 48º position
[SRR-LWE-2011-00156]

7.1.2 Submersible Mixer Pump (SMP)

SMPs are used to mix the bulk waste and sludge heel for removal by STPs. The waste is mixed by oscillating the nozzles or aiming the pump discharge at the area of the tank targeted for cleaning. The waste mixing and suspension allows for more waste to be captured for removal. These pumps are effective on sludge that has hardened over time.

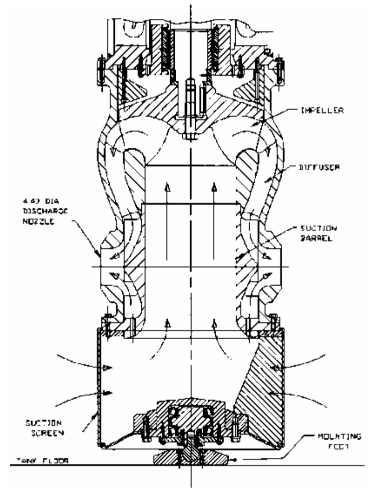
SMPs are a custom designed assembly consisting of a submersible, centrifugal, short shaft, pump that is cooled and lubricated by the slurried media. The SMPs were designed to operate in a high radiation field. Based on the construction materials, the design life of an SMP for radiological exposure was determined to be 10,000 hours/ten years. The SMPs also have fewer flanges and valves on the exterior shell which makes decontamination easier than a SLP. The SMPs are equipped with two horizontally opposed discharge nozzles and have an ECR of approximately 52 feet. [SRR-CWDA-2014-00003] The SMP pump and motor arrangement is shown on Figure 7.1-3. The SMP hydraulic flow is shown on Figure 7.1-4. [LWO-LWE-2007-00017]

Figure 7.1-3: Submersible Mixer Pump and Motor Arrangement



[LWO-LWE-2007-00017]

Figure 7.1-4: Submersible Mixer Pump Hydraulic Flow Configuration



[LWO-LWE-2007-00017]

The SMPs were designed to operate either resting on the waste tank floor or while hanging in a riser. The pump design also takes into account the possible forces generated from another SMP located 35 feet away. The SMPs were also designed to operate in oscillatory and indexing modes. During oscillatory mode operation, control cable management restricts the SMP rotation to 210 degrees, which is still adequate for full spray coverage of the waste tank. [M-SPP-G-00302] In indexing mode, the SMP spray nozzles can be directed at a particular area of the waste tank.

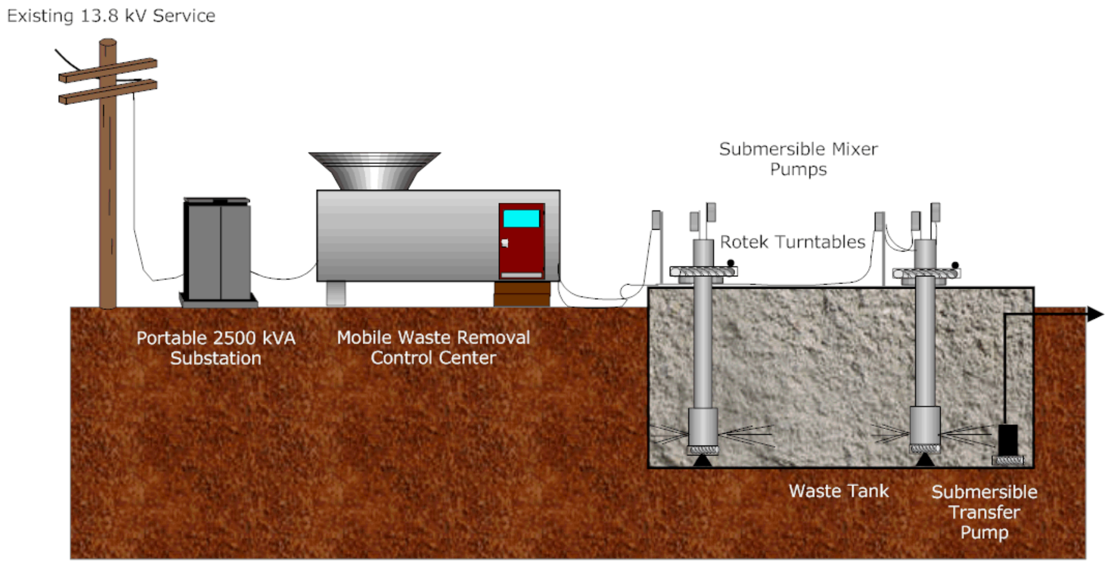
Testing at TNX using a kaolin clay and sand mixture indicated that the SMPs would be suitable for sludge removal. A 17 wt% solids clay/sand mixture was used to simulate sludge in the waste tanks. During the TNX simulation, the SMPs were run full speed for 96 hours. After the testing, the SMPs were completely disassembled and the parts checked for detrimental wear. The testing indicated that a 10,000-hour operational lifespan could be expected based on the test criteria. [LWO-LWE-2007-00017]

The TNX testing determined SMP operation required at least 44 inches of liquid above the bottom of the SMP foot for priming and starting. The minimum speed at which the SMP could operate required at least 30 inches of liquid above the SMP foot. [CBU-LWD-2005-00067, U-ESR-F-00024]

In an early application of this technology, two SMPs were used and considered sufficient because the two pumps were able to suspend the sludge into a slurry for an entire waste tank. [M-CLC-G-00349] With an approximate 52-foot ECR compared to the approximate 26-foot ECR for SLPs, two SMPs could effectively be substituted for four standard SLPs. The SMPs could also fit through the 24-inch diameter riser openings in the Type I tank. The 10,000-hour operational life expectancy of an SMP pump is greater than the 8,000 hours for a SLP. [LWO-LWE-2007-00017] SMPs have another advantage because they are floor-mounted pumps and eliminate the need for infrastructure modifications to the tank top. [G-ESR-G-00051] Subsequent application of this technology has been to deploy three or four SMPs within a tank to achieve more thorough mixing which results in smaller residual sludge heels.

A mobile control center, called Waste on Wheels (WOW) was designed to control most of the equipment needed for waste removal efforts. This system allows the SMPs to be more portable and make pump transfers between waste tanks easier. A diagram of the SMP waste removal system is shown in Figure 7.1-5. This equipment includes Variable Frequency Drives (VFDs) that are used to control the frequency settings for the SMPs and STP. Alarms and waste tank level instrumentation required for operation are also included in the mobile control center. In addition to the mobile control center, a 2,500 kVA substation was used to provide power for waste removal efforts.

Figure 7.1-5: Submersible Mixer Pump Waste Removal Diagram



[DOE/SRS-WD-2012-001]

7.1.3 Commercial Submersible Mixing Pump (CSMP)

A team was formed in 2012 to evaluate alternate strategies or technologies for removing waste and closing tanks. The team determined that the current mixing technology was the best available method to remove sludge from the waste tanks. However, lower-cost "off the shelf" CSMPs were identified as a potential significant reduction in cost, but with increased risk of failure. The reduced cost meant that these pumps could be used to failure and then disposed of, or grouted in place in the waste tank during final closure. Currently pumps are moved between tanks, which is costly and creates the potential for personnel exposure. CSMPs have a calculated 29-foot ECR and will perform the same tasks as SMPs for bulk waste removal. [SRR-CWDA-2014-00003] One CSMP has been tested at TNX to confirm meeting the design criteria and prove the ability of the pump to operate in a waste tank. [SRR-STI-2014-00571] CSMPs are planned for use in upcoming phases of waste removal. Figure 7.1-6 shows a CSMP.

Figure 7.1-6: Commercial Submersible Mixing Pump

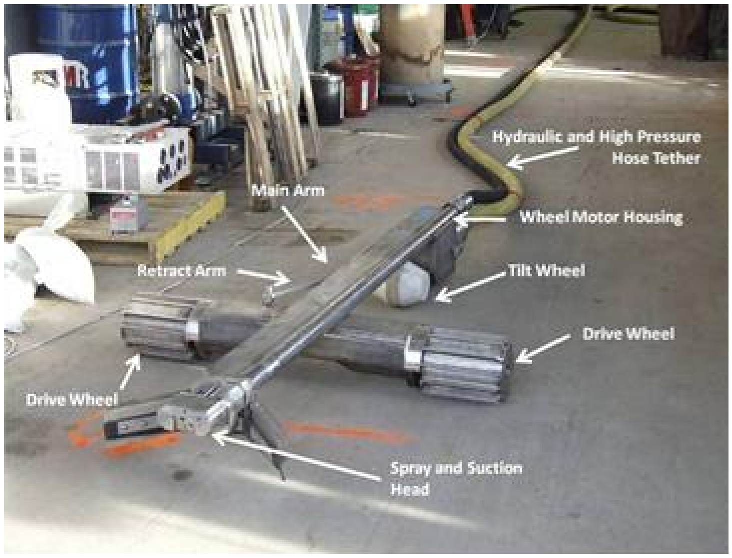
7.1.4 Mechanical Feed and Bleed (MFB)

This MSR method uses mixing pumps and water addition for sludge heel removal. Water is added (fed) to the tank and mixed using the pumps to produce a slurry. The waste slurry is then transferred (bled) out of the tank. This "mechanical feed and bleed" process is repeated until waste is no longer being removed.

7.1.5 Mantis Crawler

Because Type IV tanks do not contain cooling coils, Mantis crawler technology can be used to remove waste from the waste tank floor. The crawler head is equipped with an eductor that aspirates material off the floor and transfers the suspension to a nearby waste tank. The crawler can also be equipped with forward pointing water-spray nozzles to dislodge and suspend hardened material. The crawler motion is remotely controlled by an operator using a multi-function joystick while observing the movement on a video screen. As recognized during use in Tanks 18F and 19F, the Mantis performance was dependent on the physical properties of the waste. Figure 7.1-7 is a picture of the Mantis crawler.

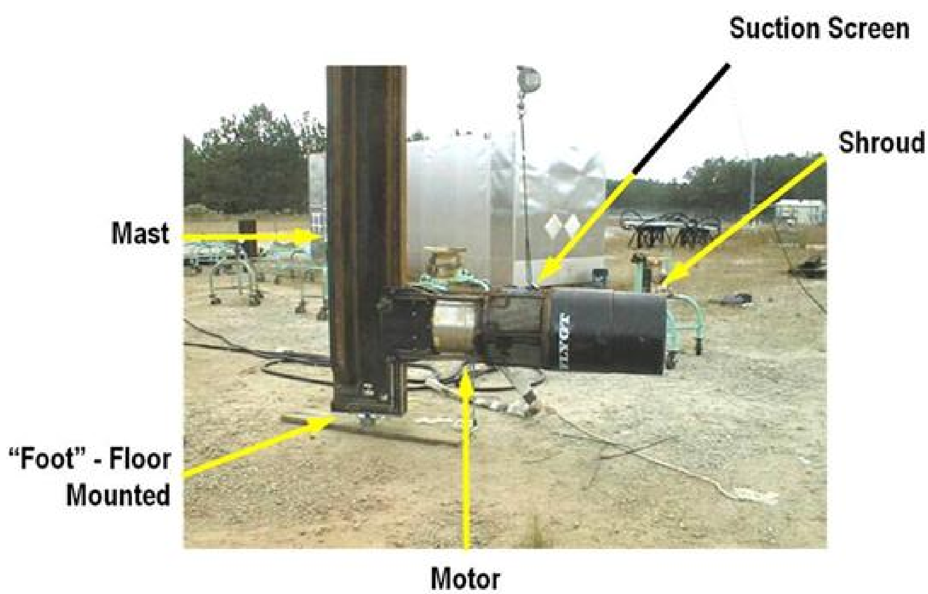
Figure 7.1-7: Mantis Crawler



7.1.6 Free Jet Flow Agitator (Flygt Mixer)

Flygt mixers are small agitators primarily used to mix tank contents into a homogeneous blend. These mixers are manufactured by ITT Corporation and are commonly used to suspend municipal sludge in wastewater treatment plants. Flygt mixers with 20-inch diameter impeller blades inside the shroud were used in Tank 19F to mix the sludge and zeolite present in the tank. Figure 7.1-8 shows a Flygt mixer.

Figure 7.1-8: Flygt Mixer used in Tank 19



7.1.7 Advanced Design Mixer Pump (ADMP)

The ADMP was a larger, more powerful pump than the SMP that was in development at the same time. The ADMP was originally conceived by the Hanford Site and supported by SRS to provide a more reliable and maintainable mixer pump for use throughout the DOE complex. Between 1998 and 2002, the ADMP underwent an extensive test program at SRS to assess reliability and hydraulic performance. The ADMP was a departure from the SLP design. Like the SLP, the ADMP was a long-shaft, vertical, centrifugal mixer pump with two tangential nozzles. The ADMP does not fit through a 2-foot diameter opening, but will fit through the 10-foot inside diameter tank center riser on an FTF Type IV tank. The theoretical ECR was over 50 feet. However, despite the relatively high horsepower, the ADMP underperformed when used in Tank 18F, primarily due to pump inlet screen plugging. The large diameter also precludes use in non-Type IV tanks. Since the pump was not suitable for most risers and because the SMP offered similar performance, further development was not pursued.

7.2 Chemical Sludge Removal (CSR)

When implemented, CSR campaigns remove to varying degrees, various chemical species comprising the waste. CSR involves the addition of chemicals into the waste tank and may be used during the waste heel removal phase to facilitate waste removal. In the future, additional approaches may become available or modifications may be made to existing processes to improve waste removal.

7.2.1 Bulk Oxalic Acid Cleaning (BOAC)

When BOAC is used, the waste tank is typically filled with oxalic acid (OA) to a level that allows mixer pump operation. Following OA addition, the waste tank contents are agitated and then the dissolved and slurried sludge is transferred to a receipt tank for neutralization.

OA is one of the strongest of the organic acids and it readily oxidizes (combines with metal ions such as iron, calcium, or magnesium) to form oxalates, which are less soluble in water than OA. Tests at SRNL in 1977 showed the sludge dissolution rate increased with increased OA temperature, agitation, OA concentration, amount of OA addition, frequency of OA addition, and amount of sludge surface exposed. The testing also showed that Sr-90 dissolved in OA at about the same rate as the total sludge volume, which is important since Sr-90 is responsible for a large percentage of radioactivity in the sludge. [DP-1471]

OA may also favorably change the sludge rheology and improve the removal of insoluble solids from the waste tank. However, use of BOAC for CSR campaigns in Tanks 5F, 6F, and 12H showed that the addition of OA, dilution with water, and agitation using pumps had to be carefully monitored to control the formation of insoluble oxalates and the time when CSR effectiveness reaches the point of diminishing returns. In the future, modifications to the BOAC approach may be made to improve the process.

7.2.2 Low Temperature Aluminum Dissolution (LTAD)

LTAD is a chemical cleaning technique applicable to waste tank sludge having a high aluminum content. "Low Temperature" refers to the use of a maximum temperature of approximately 75°C to achieve the dissolution. In LTAD, concentrated supernate high in hydroxide content (and low in dissolved aluminum), or concentrated sodium hydroxide are added to the remaining tank solids until the minimum liquid level required for mixing pump operation is reached. The waste tank contents are agitated until the tank reaches a temperature sufficiently high enough for the aluminum dissolution reaction to occur. By dissolving the aluminum compounds, the waste rheology is successfully modified for more effective suspension and mixing and the waste tank contents can be transferred to a receipt tank.

Lessons learned during LTAD showed that the problem was achieving, maintaining, and operating the waste tank at the necessary temperature. Waste tank components also need to be sufficiently robust and extensive technical evaluations are required before subjecting a specific waste tank to such harsh processing conditions.

7.2.3 Saltcake Dissolution

Many of the waste tanks contain crystallized supernate called saltcake. Saltcake is a mixture of complex double and triple salts and aluminosilicates that can present challenges to dissolution and removal. Saltcake composition can vary significantly between waste tanks and even between locations in a waste tank, which further complicates removal. [SRR-LWE-2014-00169]

Most of the saltcake removal techniques involve salt dissolution using water or supernate and pumping of the dissolved saltcake. Sometimes the dissolution techniques use agitation to improve the contact between the saltcake and fluid. Tank-specific conditions will determine the actual implementation and several techniques may be combined or modified to cope with operational challenges.

The common dissolution approaches used are:

- Add, Sit, Remove/Molecular Diffusion (ASR/MD): Dissolution water is added to a standing layer of supernate present above the salt in a waste tank. The method relies on concentration gradients within the liquid to promote contact between the saltcake and the water.
- Modified Density Gradient (MDG): A transfer pump or jet is burrowed through the saltcake to reach a low level in the tank and create a cavity. Dissolution water is then added above any remaining supernate. As saturated solution is removed from the bottom of the cavity, more water is added to maintain the liquid level. Best results are obtained when a steady-state “feed and bleed” operation is maintained and a fully saturated solution is removed.
- Drain, Add, Sit, Remove (DASR): This modification to the MDG approach, used after the pump cavity is burrowed into the saltcake, allows the dissolution water to sit in contact with the saltcake before removal, rather than being slowly removed and replenished. This method promotes excellent contact with the saltcake with minimal wait time.
- Semi-Continuous Dissolution (SCD): Dissolution water is slowly added at the same rate the dissolution water is removed. Low volume mixing eductors add the dissolution water at multiple locations in the tank to maximize contact with saltcake.

SCD appears to be the most effective. The SCD process allow for efficient salt dissolution while avoiding the need to monitor the controls for trapped hydrogen gas release.

7.3 Tank Closure Cesium Removal (TCCR)

TCCR is a proposed technology that uses an ion exchange technique for "at tank" cesium removal from salt waste. The approach involves treatment of the saltcake dissolution waste stream with an ion exchange resin to remove Cs-137. The system design and construction would be subcontracted with the cesium-rich resin going to interim safe storage while the treated effluent would go into the tank waste disposal stream. The TCCR technology is currently mature enough for evaluation as a demonstration project. A contract has been awarded for the design and fabrication phase for use at Tank 10H for filtration and cesium removal of dissolved salt solution removed from Tank 10H. TCCR could potentially accelerate and expedite salt processing efforts.

8.0 WASTE CHARACTERIZATION

After DOE receives letters from EPA and SCDHEC agreeing to suspend waste removal, DOE will characterize the residual materials remaining in the waste tank or ancillary structure to determine the actual inventory of chemical and radiological constituents and validate the applicable tank farm's PA modeling. The residuals characterization is not meant to demonstrate compliance with the performance objectives but rather to determine through the Special Analysis (SA) if the source term remaining in the waste tank or ancillary structure provides reasonable assurance that the performance objectives will be met throughout the evaluation period.

The residuals in each waste tank or ancillary structure will be characterized using the methodology and requirements in the *Liquid Waste Tank Residuals Sampling and Analysis Program Plan* (LWTRSAPP) and *Liquid Waste Tank Residuals Sampling - Quality Assurance Program Plan* (LWTRS-QAPP) that were reviewed and approved by the SCDHEC and EPA. [SRR-CWDA-2011-00050, SRR-CWDA-2011-00117] In some cases, process knowledge and historical sampling may be used to support residuals characterization.

Tank-Specific Sampling and Analysis Plans (TSAPs) will be subsequently developed to manage the material variations and residual waste distributions expected between waste tanks, or in ancillary structures, and will be consistent with the requirements of the LWTRSAPP. The TSAP will include the number of planned samples, the initial sample locations, the sample weights desired, the sample collection techniques, and the list of chemical and radiological analytes. Sampling methods and tools will be developed as necessary to collect and analyze representative samples of the residual solid materials and, if necessary, for any liquids present. [SRR-CWDA-2011-00050]

A number of waste tanks have residual material in the annular space as the result of leakage through cracks in the primary liner wall. Annulus material sampling may be warranted if there is sufficient material volume present at the time of primary tank sampling. The use of any annulus material samples for composite sample creation or discrete sample analyses, and the analyte list will be evaluated on a tank-specific basis.

If residuals in an ancillary structure require sampling for characterization, a sampling approach and plan consistent with the LWTRSAPP to collect and analyze representative samples will be developed. [SRR-CWDA-2011-00050]

Sample collection may be video recorded and/or photographed in a manner that documents the location of each sample and the sampling technique. The chain-of-custody process described in the LWTRSAPP will be used to document sample collection and transport to the laboratory. [SRR-CWDA-2011-00050]

8.1 Residual Material Volume Determination

The TSAP is developed for the residuals remaining in a tank or ancillary structure using a preliminary residuals volume estimate and distribution map. Residual material segments for sampling, initial sample locations, and number of samples to be collected will be determined using the rationale and methodology described in the LWTRSAPP. [SRR-CWDA-2011-00050]

The final residuals volume determination and uncertainty estimate are developed during the sample collection using additional photographs and video coverage from the on-board robotic crawler optical system, cameras lowered into the tank to record sampling, and waste thickness estimates made during actual sample collection. The personnel performing the residual material mapping are trained as described in the LWTRS-QAPP and use the process described in Tank Mapping Methodology. [SRR-CWDA-2011-00117, SRR-LWE-2010-00240]

If new mapping technologies such as sonar or laser ranging and imaging become available in the future for residual volume determinations, they will have similar quality assurance requirements as the current mapping methodology.

8.2 Derivation of Constituents of Concern and Analytes

Chemical and radiological constituents in the waste tanks are tracked using an electronic information system called the Waste Characterization System (WCS). The WCS consists of two Excel workbooks that track selected waste tank data, including radioactive and non-radioactive inventories based on sample analyses, process histories, composition studies, and theoretical relationships. WCS is based on a relatively sophisticated model that estimates the quantity of materials disposed to and transferred between tanks as well as the average compositions of the various waste streams. The main purpose of the model is to provide reasonable constituent estimates on which to base safety analysis evaluations in the tank farms. [SRR-LWE-2011-00201]

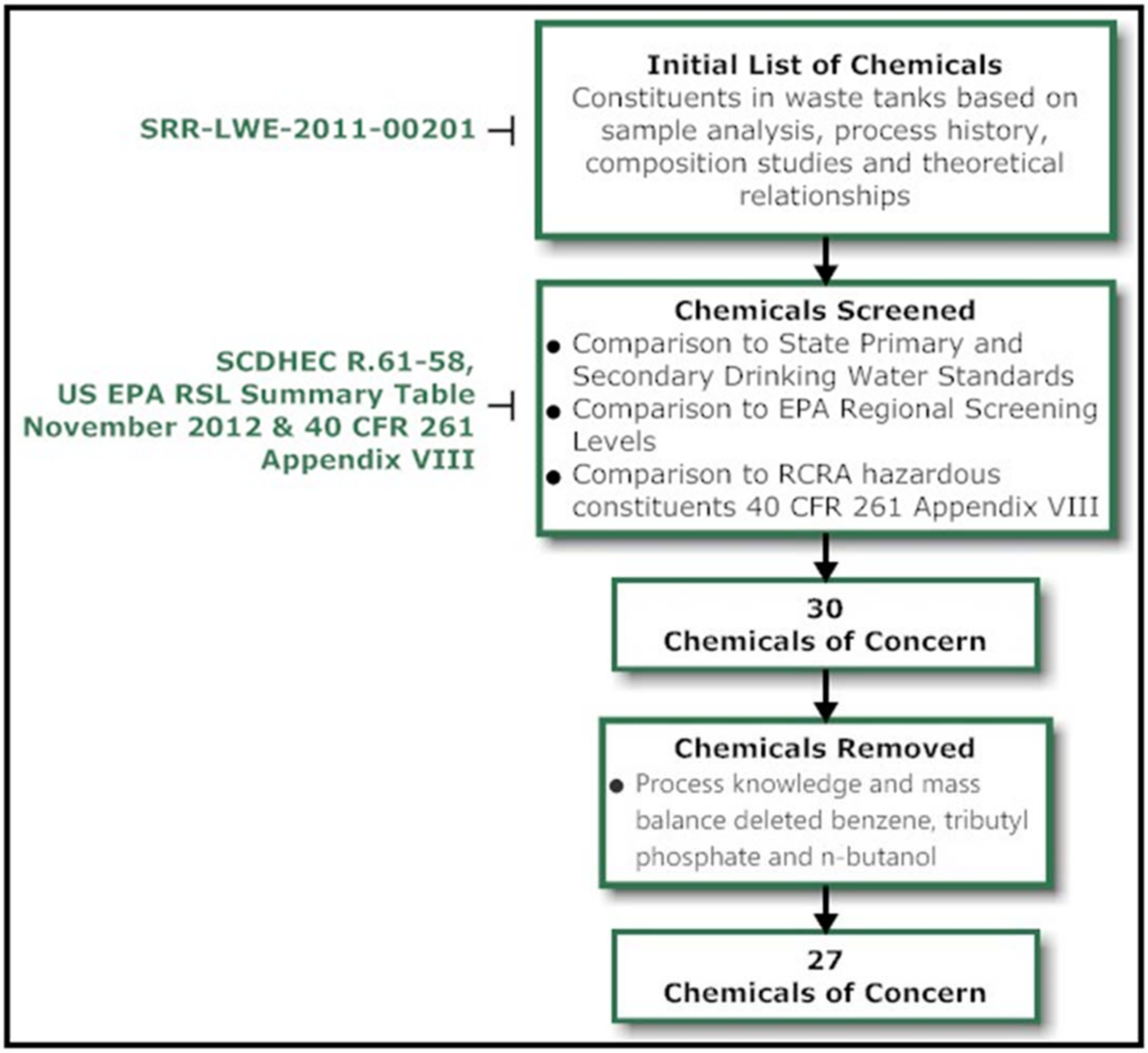
The WCS report listing the chemical and radiological constituents found in tank waste is the *Information on the Radiological and Chemical Characterization of the Savannah River Site Tank Waste as of July 5, 2011* (SRR-LWE-2011-00201), which includes constituents that were received into the FTF or HTF over the facility history as well as any constituents that could have formed in the tank sludge, salt, or supernate phases. The chemical inventories reported are the best available information or estimated values used to support liquid waste management safety and operational decisions. Because this information is used for safety purposes (e.g., nuclear criticality evaluations, corrosion evaluations), the inventories are approximate and may overestimate or underestimate the actual inventories for constituents not involved in safety basis calculations. [SRR-LWE-2011-00201] This report was used to develop the initial analyte lists for constituents of concern in the tank residuals.

8.2.1 Chemical Constituent Screening and Analyte List

The chemical constituents of interest were identified through a screening process using EPA Regional Screening Levels (RSLs) (EPA_RSL_Tbl_11-2012), maximum contaminant levels (MCLs) from the State Primary Drinking Water Regulation for inorganic contaminants specified in SCDHEC R.61-58, and hazardous constituents from 40 CFR 261 Appendix VIII. Those chemical constituents expected to be present in the waste tanks that also appeared on the list of chemicals having RSLs, MCLs, or hazardous characteristics were added to the chemicals of concern (COC) list. Based on the operational history of the specific tank or ancillary structure, chemical instabilities, or other process knowledge factors, certain organic chemicals (e.g. tributyl phosphate, benzene, and n-butanol) were also eliminated from the COC analyte list for the majority of the waste tanks. The basic screening process for the COCs is shown on Figure 8.1-1.

The COC analyte list will be determined for each waste tank or ancillary structure being removed from service by evaluating which constituents might be present and require characterization. The COC analyte list will be specified in the TSAP. The typical chemical constituent analytes are shown in Table 8.1-1.

Figure 8.1-1: Chemicals of Concern Screening Process



[SRR-CWDA-2014-00052]

Table 8.1-1: Typical Chemical Analytes for Residual Material Sample Analyses

Chemical	Chemical
Ag	Mn
Al	Mo
As	Ni
B	NO_2
Ba	NO_3
Cd	Pb
Cl	PO_4
Co	Sb
Cr	Se
Cu	SO_4
F	Sr
Fe	U
Hg	Zn
I	

8.2.2 Radionuclide Constituent Screening and Analyte List

As explained in *Savannah River Site High-Level Waste Tank Farm Closure, Radionuclide Screening Process (First-Level), Development and Application*, (CBU-PIT-2005-00228), the initial radionuclide analyte list included 849 potential radionuclides and any radionuclide daughters that might be present in the waste tank. For reasons such as short half-life, no associated production history, and low risk, 690 were excluded from further consideration.

Based on the presence/absence of parent radionuclides and the expected waste tank inventory, additional screening was performed for the remaining 159 isotopes as described in HTF PA Section 3.3.2 (Evaluation of Remaining Radionuclides) and FTF PA Section 4.2.1.3 (Evaluation of Remaining Radionuclides). [SRR-CWDA-2010-00128, SRS-REG-2007-00002]

As shown on Figure 8.1-2, the additional screening yielded an initial list of 54 radionuclides of concern for the HTF residuals characterization. The same screening process was used to identify the FTF radionuclides of concern. The typical radionuclide analytes for both the FTF and HTF are listed in Table 8.1-2. Based on the individual waste receipt history for the waste tank or ancillary structure, the analyte list will be adjusted and radionuclides may be added or deleted. Some daughter product radionuclides may be evaluated by analysis of the parent radionuclides rather than by direct analysis. As more waste tanks are characterized, and analytes are shown to be absent, or present in negligible quantities, the list may be shortened.

Figure 8.1-2: Radionuclides of Concern Screening Process for the HTF PA

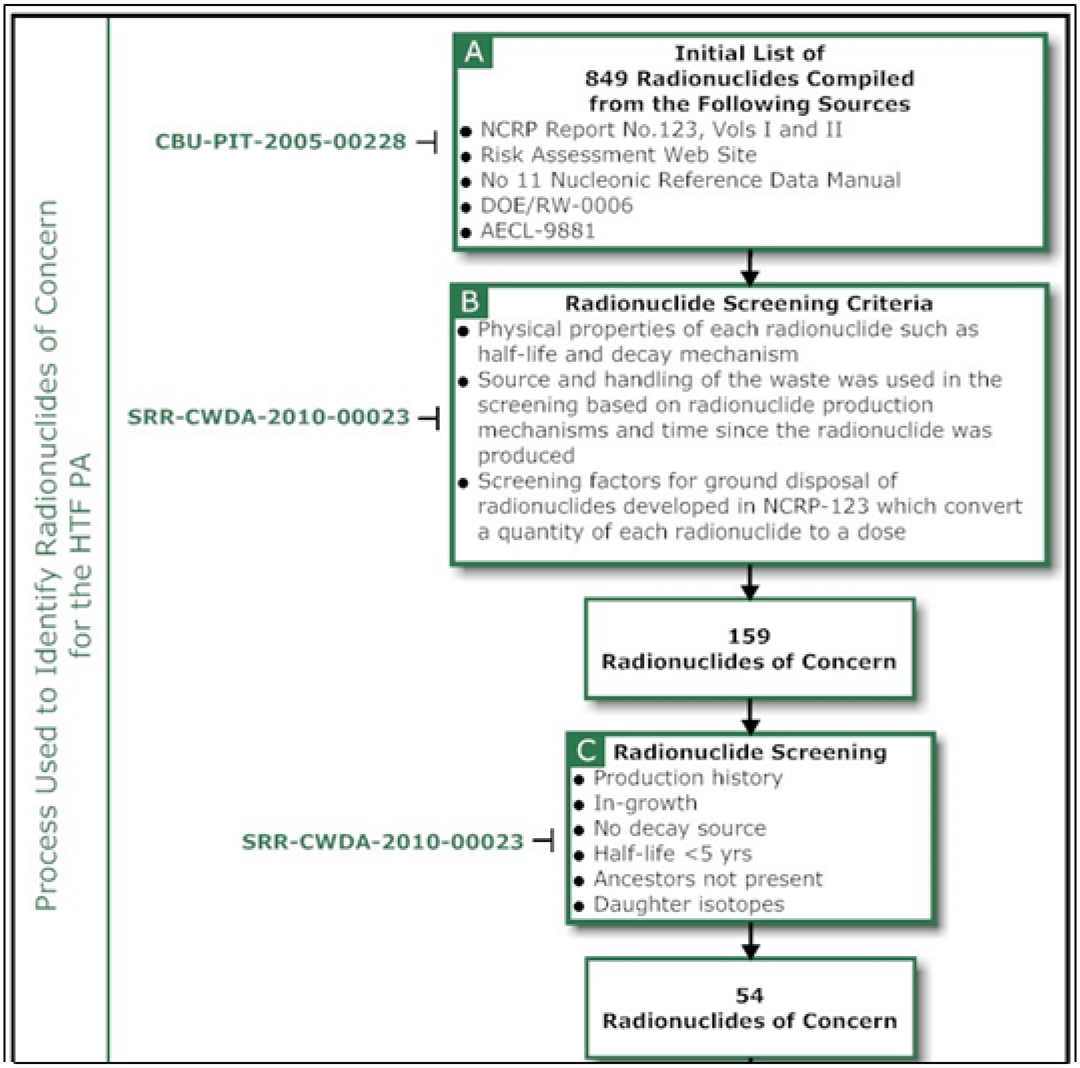


Table 8.1-2: Typical Radionuclide Analytes for Residual Material Sample Analyses

Radionuclide	Radionuclide	Radionuclide	Radionuclide
Am-241	Cs-137	Pu-240	U-232
Am-242m	I-129	Pu-241	U-233
Am-243	K-40	Ra-226	U-234
Ba-137m	Nb-94	Ra-228	U-235
C-14	Ni-59	Sn-126	U-238
Cl-36	Ni-63	Sr-90	Y-90
Cm-243	Np-237	Tc-99	Zr-93
Cm-244	Pa-231	Th-229	
Cm-245	Pu-238	Th-230	
Cs-135	Pu-239	Th-232	

8.3 Sample Analyses

The laboratory will analyze the residual material samples for the chemical and radionuclide analyte list established for the specific waste tank or ancillary structure being removed from service. These analyses are expected to be challenging due to the low requested detection limits and the difficult separations often required for some analytes. As necessary, residual materials other than the solids customarily found on waste tank floors may require characterization. These analyses may require the development of different analyte lists, detection limits, and analysis methods.

A statistical analysis of the sampling results will be performed to provide the means, standard deviation, and upper 95% confidence limit (UCL95) on the mean for those analytes with measured concentration values. For those analytes where the concentration was non-detected or less than the target detection limit (TDL), the lowest and highest minimum detectable concentrations (MDCs) will be used to bound the concentration values for the analyte. Details on the statistical analysis and evaluation of analytes with a mixture of detected and non-detected concentrations will be presented in the tank specific sample analysis report.

8.4 Data Quality Assessment

A Data Quality Assessment (DQA) will be performed to assess the data quality of the specific residual material sampling and analyses. The areas of precision, accuracy, representativeness, comparability, completeness, and the statistical analysis will be reviewed to determine if the data quality objectives have been met and the data can be used for the residual material characterization and subsequent inventory determination.

8.5 Final Inventory Determination

Following the DQA, the approved data are used to determine the actual residuals inventory for the waste tank or ancillary structure. The constituent concentrations and final residual material volume(s) are used to determine the final inventory for the waste tank or ancillary structure. As necessary, inventories will also be determined for material in the annulus, equipment hold-up, liquids, contaminated sand pads, or other residual materials present. The final inventory is the total amount of chemicals and radionuclides that will remain in the tank or ancillary structure when it is removed from service. The final inventory determination is provided in the CM, used for input to the SA, and to update the applicable waste tank or ancillary structure inventory in the respective PA when it is revised.

8.5.1 Forecasted Inventory Closure Module Approach

Residuals characterization and final inventory determination is a lengthy process and can be further complicated by difficulties encountered during both the sampling and analysis. To shorten the schedule to remove a waste tank from service and begin grouting, an alternate CM preparation and submittal approach using a forecasted residuals inventory was developed and used during the characterization of Tank 12H. The alternate CM approach is described in Section 11.3.

9.0 PERFORMANCE EVALUATION

SRS has completed comprehensive PAs that provide the results used to evaluate residual contaminant status in the waste tank systems over time. The PAs provide reasonable assurance that the FTF and the HTF waste tank systems will meet applicable performance objectives after they are removed from service. A major component of the applicable performance objectives involves groundwater fate and transport modeling. Evaluation of the performance objectives involved all media and pathways and showed that the groundwater concentrations are the primary contributors to the all-pathways dose to a member of the public (MOP). [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

An integrated conceptual model (ICM) was prepared for each PA to evaluate the performance of the respective tank farm following the removal from service of all waste tank systems and ancillary structures. The two ICMs differ in tank farm specific details such as depth to groundwater, tank type(s) and locations, tank-specific inventories, etc. Each tank farm's ICM contains three related conceptual flow models that represent the environmental media through which released contaminants may migrate: 1) closure cap model, 2) vadose zone model, and 3) saturated zone model.

The ICM simulates the release of radiological and chemical contaminants from the underground waste tanks and associated ancillary structures as well as the migration of the contaminants through soil and groundwater. An independent, waste release sub-model was used in both PAs to simulate the contaminant release from the stabilized waste tanks based on various chemical phases controlling solubility and transport that would affect the timing and release rate of the residual inventory. The ICM also considers the integrity of the waste tank steel liners and cementitious barriers in the modeling, with the barriers degrading over time. Details on each ICM are presented in the respective FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

DOE utilizes a MOP exposure pathway dose methodology to convert radionuclide concentrations to total effective dose equivalent (TEDE) values for comparison against the performance objectives using the most recent dose conversion factors (DCFs), elemental transfer factors, and individual MOP consumption and exposure rates. As the residuals are characterized in each waste tank system, an SA will be performed to evaluate the updated inventory impacts against the performance objectives established in the associated PAs.

The evaluation process described in the PAs has been developed to allow individual waste tank removals from service to proceed, while recognizing and considering the uncertainty of the source terms for the waste tanks that have yet to undergo final waste removal operations. The FTF and HTF PAs will be maintained per the requirements of DOE M 435.1-1 and updated as needed when new information becomes available.

9.1 Constituents Included in Groundwater Modeling

9.1.1 Chemical Constituent Screening

The lists of chemical, i.e., non-radiological constituents modeled in the FTF and HTF PAs were developed using the screening process described in Section 8.2. The chemical modeling lists are provided in the respective PAs and differ slightly for each tank farm because of differences in waste processing history.

9.1.2 Radiological Constituent Screening

The screening process described in Section 8.2 was used to develop the list of 54 radionuclides for the FTF and HTF PA fate and transport modeling. The radionuclide modeling lists are provided in the respective PAs, and differ slightly for each tank farm because of differences in waste processing history.

9.2 Applicable Performance Objectives for Predictive Modeling

The groundwater modeling performance objectives applicable to the FTF and HTF waste tank system removals from service are:

1. The *State Primary Drinking Water Regulations* for radionuclides (i.e., 4 mrem/yr beta-gamma dose, 15 pCi/L total alpha concentration, and 5 pCi/L total Ra-228 + Ra-226)
2. The *State Primary Drinking Water Regulations* for nonradiological inorganic constituents.

These performance objectives are used only in the PA process to provide reasonable assurance that at the time of final FFA corrective/remedial actions, the predicted groundwater concentrations derived from residual contamination in the waste tanks and ancillary structures will be within the MCLs. The SCDHEC *State Primary Drinking Water Regulations* constituents and associated MCLs are listed in Table 9.2-1. [SCDHEC R.61-58] Additional constituents of concern with RSL or action level concentrations that are modeled in the PAs are also shown in Table 9.2-1. Applicable waste tank closure regulations will be evaluated periodically to ensure that closure objectives are up-to-date and based on the regulations in effect when CMs are developed.

Table 9.2-1: Constituents Modeled in the PAs Having SCDHEC Primary and Secondary Drinking Water Standards, Action Levels, RSLs, or MCLs

Constituent	Units	MCL, RSL, or Action Level Value
Radiological		
Beta-gamma dose [a,b]	mrem/yr	4.0
Alpha concentration [a,b]	pCi/L	15
Total Ra-228 + Ra-226 [a,b]	pCi/L	5.0
Uranium (U)	µg/L	30
Chemical		
Antimony (Sb)	µg/L	6.0
Arsenic (As)	µg/L	10
Barium (Ba)	µg/L	2,000
Cadmium (Cd)	µg/L	5.0
Chromium (Cr) [c]	µg/L	100
Copper (Cu)	µg/L	1,000[d]
Fluoride (F)	µg/L	4,000
Iron (Fe)	µg/L	300[d]
Lead (Pb)	µg/L	15[e]
Manganese (Mn)	µg/L	50[d]
Mercury (Hg)	µg/L	2.0
Nickel (Ni)	µg/L	390[f]
Nitrite (NO_2) + Nitrate (NO_3) as N	µg/L	10,000
Selenium (Se)	µg/L	50
Silver (Ag)	µg/L	100[d]
Zinc (Zn)	µg/L	5,000[d]

[a] Constituents identified in Section 5.7 of the FTF PA (SRS-REG-2007-00002); significant beta-gamma constituents include I-129, K-40, and Tc-99; significant alpha constituents include Np-237, Pa-231, Pu-239, Pu-240, and Th-229 (total alpha in the *State Primary Drinking Water Regulations* does not include uranium isotopes).

[b] Constituents identified in Section 5.7 of the HTF PA (SRR-CWDA-2010-00128) provided for information; significant beta-gamma constituents are Se-79 and Tc-99; significant alpha constituents include Np-237, Pu-239, Pu-240, U-233, and U-234 (total alpha in the *State Primary Drinking Water Regulations* does not include uranium isotopes).

[c] Total chromium (chromium III and VI)

[d] Secondary Drinking Water Standard MCL

[e] Action level concentration, not an MCL

[f] EPA RSL (May 2016) for nickel soluble salts [EPA_RSL_Tbl_05-2016]

9.3 Contaminant Migration Constituents of Concern

In the FTF and HTF PAs, Contaminant Migration Constituents of Concern (CMCOCs) were identified through a system that is consistent with both the Area Completion Project protocols and the PAs. The CMCOCs were identified by modeling the hypothetical contaminant release and migration through the vadose zone. Those contaminants predicted to reach the water table were compared to MCLs or regional screening levels. Any constituents that were predicted to exceed these standards in the groundwater directly beneath the associated tank farm were identified as CMCOCs.

The FTF PA identified only cadmium (Cd) and manganese (Mn) as the two chemical CMCOCs. The radiological CMCOCs identified were: I-129, K-40, Np-237, Pa-231, Pu-239, Pu-240, Ra-226 + Ra-228, Tc-99, Th-229, U-233, U-234, U-236. [SRS-REG-2007-00002]

The HTF PA (Revision 1) did not identify any chemical or radiological CMCOCs. [SRR-CWDA-2010-00128]

These lists will be re-evaluated and updated as necessary in the future as more information becomes available and/or regulations change.

9.4 Assessment Evaluation

As described in Sections 2.4.2 and 2.4.3 of both PAs, the *Savannah River Site Long Range Comprehensive Plan* (PIT-MISC-0041) is founded on the following assumptions:

- SRS will be owned and controlled by the Federal government in perpetuity,
- The property will be used only for industrial purposes,
- Site boundaries will remain unchanged, and
- Residential use will not be allowed on-site.
  [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

Therefore, a scenario in which a future hypothetical MOP establishes a residence directly atop the FTF or HTF and obtains drinking water from the water table below is extremely unlikely. More plausible, although still highly unlikely, locations for the future MOP to be exposed to groundwater originating below the FTF would be at the Upper Three Runs (UTR) seepline or the Fourmile Branch (FMB) seepline located at least 1,600 meters from the FTF. For groundwater originating below the HTF, the exposure point would be either at the UTR seepline 2,400 meters northwest of the HTF or at the FMB seepline 1,200 meters southwest of the HTF.

The FTF and HTF PAs have shown that there is reasonable assurance that human health and the environment will continue to be protected after the waste tank systems have been removed from service. [SRS-REG-2007-00002, SRR-CWDA-2010-00128] For each waste tank system that is characterized and removed from service, an SA will be performed using the updated waste tank system inventories to validate and document that the assumptions made in the associated PA remain protective.

9.5 Modeling to Predict Groundwater Impacts

The PA modeling has estimated the groundwater concentrations of radiological and chemical constituents at various FTF and HTF perimeter locations and has shown that, at the time of final FFA corrective/remedial actions, there is reasonable assurance that the groundwater concentrations derived from the expected residual inventories in the tanks and ancillary structures will be within the MCLs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128] Sections 4.8 and 5.7 in each PA describe the application of human health and ecological risk assessment protocols, typically used for area closures, to the waste tank systems. The risk assessment evaluates groundwater concentrations for contaminants that are expected to be present in the waste tank residuals. The CM will report the modeled peak groundwater concentrations and peak dose, based on the actual data from those waste tank systems that have been removed from service and the estimated inventory of those waste tank systems that have not yet been cleaned. This analysis will be documented in an SA that evaluates the updated inventory impacts against the performance objectives described in Section 9.2.

To predict the contribution of the waste tank residuals to the groundwater, as it relates to the *State Primary Drinking Water Regulations*, SCDHEC R.61-58, the concentrations of the significant alpha-emitting radionuclides (excluding radon and uranium) are added together for any given year occurring during the DOE 1,000 year compliance period following closure of the associated tank farm and the highest summed concentration (known as the peak year concentration) is compared to the alpha MCL of 15 pCi/L. [SRS-REG-2007-00002, SRR-CWDA-2010-00128] This is also the method to predict the contribution to the MCL of 5 pCi/L for total Ra-226 + Ra-228. For total uranium, the predicted concentration each year is compared to the MCL value of 30 µg/L.

The prediction of the beta-gamma groundwater dose is performed in the same manner. The dose contribution is determined by comparing the concentration of each significant beta-gamma emitter in the groundwater with the EPA-calculated derived concentration for each radionuclide that would provide a beta-gamma dose of 4 mrem/yr (Table 9.5-1). The fractions (i.e., groundwater concentration divided by derived concentration) for each beta-gamma emitter are then summed to determine the peak year values during the DOE 1,000 year compliance period following closure of the associated tank farm. The highest sum of fractions for any year is determined and verified to be less than one. To determine the peak beta-gamma dose, the fraction can be multiplied by the 4 mrem/yr MCL value. Subsequent maintenance and monitoring, as described in Section 3 will demonstrate that the performance objectives are being met.

Table 9.5-1: Derived MCL Concentrations of Beta and Photon Emitters in Drinking Water

Derived Concentrations (pCi/l) of Beta and Photon Emitters in Drinking Water

Yielding a Dose of 4 mrem/yr to the Total Body or to any Critical Organ as defined in NBS Handbook 69

Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l
H-3	20,000	Ni-65	300	Nb-95	300	Sb-124	60	Nd-147	200	Os-191	600
Be-7	6,000	Cu-64	900	Nb-97	3,000	Sb-125	300	Nd-149	900	Os-191m	9,000
C-14	2,000	Zn-65	300	Mo-99	600	Te-125m	600	Pm-147	600	Os-193	200
F-18	2,000	Zn-69	6,000	Tc-96	300	Te-127	900	Pm-149	100	Ir-190	600
Na-22	400	Zn-69m	200	Tc-96m	30,000	Te-127m	200	Sm-151	1,000	Ir-192	100
Na-24	600	Ga-72	100	Tc-97	6,000	Te-129	2,000	Sm-153	200	Ir-194	90
Si-31	3,000	Ge-71	6,000	Tc-97m	1,000	Te-129m	90	Eu-152	200	Pt-191	300
P-32	30	As-73	1,000	Tc-99	900	Te-131m	200	Eu-154	60	Pt-193	3,000
S-35 inorg	500	As-74	100	Tc-99m	20,000	Te-132	90	Eu-155	600	Pt-193m	3,000
Cl-36	700	As-76	60	Ru-97	1,000	I-126	3	Gd-153	600	Pt-197	300
Cl-38	1,000	As-77	200	Ru-103	200	I-129	1	Gd-159	200	Pt-197m	3,000
K-42	900	Se-75	900	Ru-105	200	I-131	3	Tb-160	100	Au-196	600
Ca-45	10	Br-82	100	Ru-106	30	I-132	90	Dy-165	1,000	Au-198	100
Ca-47	80	Rb-86	600	Rh-103m	30,000	I-133	10	Dy-166	100	Au-199	600
Sc-46	100	Rb-87	300	Rh-105	300	I-134	100	Ho-166	90	Hg-197	900
Sc-47	300	Sr-85m	20,000	Pd-103	900	I-135	30	Er-169	300	Hg-197m	600
Sc-48	80	Sr-85	900	Pd-109	300	Cs-131	20,000	Er-171	300	Hg-203	60
V-48	90	Sr-89	20	Ag-105	300	Cs-134	80	Tm-170	100	Tl-200	1,000
Cr-51	6,000	Sr-90	8	Ag-110m	90	Cs-134m	20,000	Tm-171	1,000	Tl-201	900
Mn-52	90	Sr-91	200	Ag-111	100	Cs-135	900	Yb-175	300	Tl-202	300
Mn-54	300	Sr-92	200	Cd-109	600	Cs-136	800	Lu-177	300	Tl-204	300
Mn-56	300	Y-90	60	Cd-115	90	Cs-137	200	Hf-181	200	Pb-203	1,000
Fe-55	2,000	Y-91	90	Cd-115m	90	Ba-131	600	Ta-182	100	Bi-206	100
Fe-59	200	Y-91m	9,000	In-113m	3,000	Ba-140	90	W-181	1,000	Bi-207	200
Co-57	1,000	Y-92	200	In-114m	60	La-140	60	W-185	300	Pa-230	600
Co-58	300	Y-93	90	In-115	300	Ce-141	300	W-187	200	Pa-233	300
Co-58m	9000	Zr-93	2,000	In-115m	1,000	Ce-143	100	Re-186	300	Np-239	300
Co-60	100	Zr-95	200	Sn-113	300	Ce-144	30	Re-187	9,000	Pu-241	300
Ni-59	300	Zr-97	60	Sn-125	60	Pr-142	90	Re-188	200	Bk-249	2,000
Ni-63	50	Nb-93m	1,000	Sb-122	90	Pr-143	100	Os-185	200		

[EPA 815-R-02-001]

10.0 REGULATORY FRAMEWORK

10.1 Waste Tank Systems Removal From Service

FTF and HTF liquid waste operations are governed by Construction Permit #17,424-IW issued by SCDHEC on January 25, 1993, modified on December 3, 1999 to include the 242-25H evaporator system, on August 17, 2001 to include Tank 50H, and again on November 23, 2010 to include Tank 16H. The permit was issued under the authority of the Pollution Control Act (PCA) and all applicable regulations implementing that Act. The State of South Carolina has approval authority for wastewater treatment facility removal from service under Chapter 61, Articles 67 and 82 of the SCDHEC Regulations. [DHEC_01-25-1993, DHEC_12-03-1999, DHEC_08-17-2001, DHEC_11-23-2010]

Waste tank systems removal from service is preceded by bulk waste removal, followed by heel removal, and finally stabilization with grout. Before any waste tank system is removed from service, DOE must present the general plan under which all the waste tank systems will be closed. Whereas this CGCP provides the framework and methodologies to be used in demonstrating compliance with regulatory requirements, each subsequent individual CM will implement those methodologies documenting the effectiveness of the specific technologies used in waste removal activities and characterizing the residuals remaining in each waste tank system. Each CM will represent an incremental removal from service related to Construction Permit #17,424-IW.

In accordance with CERCLA 42 U.S.C. §9620(e)(1) and RCRA 42 U.S.C. §§6829(h) and 6961, the DOE, EPA, and the SCDHEC entered into an FFA, effective August 16, 1993. [WSRC-OS-94-42] This agreement provides for a comprehensive remediation of SRS, governs the corrective/remedial action process from site investigation through site remediation, and describes procedures for that process. The FFA, in conjunction with applicable South Carolina law and regulation, establish the framework for the new construction, operation, removal from service, and any appropriate RCRA/CERCLA response action related to the waste tank systems. The FFA provides timetables for the removal from service of waste tanks that do not meet the secondary containment standards of FFA Section IX.C, or that leak or have leaked, as well as provisions for new construction and prevention and mitigation of releases or potential releases from the waste tank systems.

The FFA, Section IX.E, addresses the eventual waste tank and ancillary structure removals from service and any appropriate RCRA/CERCLA response action relating to the waste tank systems. The waste tanks must be removed from service in accordance with the PCA and applicable regulations implementing that Act as cited in the paragraph above. The DOE is satisfying that requirement by submitting and implementing this CGCP and the individual CMs for the waste tank systems. [WSRC-OS-94-42] Subsequent RCRA/CERCLA response actions after all of the waste tanks and ancillary structures have been removed from service will evaluate installation of an engineered closure cap over the FTF and over the HTF to provide physical stabilization and to minimize surface water infiltration. Details of the potential closure caps are in Section 3 of the FTF and HTF PAs. [SRS-REG-2007-00002, SRR-CWDA-2010-00128]

10.2 Integration of Removal from Service with Final Federal Facility Agreement Corrective/Remedial Actions

The FFA, Section IX.E.2., addresses the interface between waste tank system removals from service and any subsequent RCRA/CERCLA response action for any contaminated soils, system components, and structures that DOE cannot practicably remove or decontaminate. Those remaining contaminated soils, components, and structures that cannot be removed or decontaminated will be addressed in accordance with the response action provision (Sections XI through XVI) of the FFA. The FFA provides that SCDHEC is the designated oversight agency for review and approval of all response action documents leading up to the proposed plan. Furthermore, DOE must obtain written concurrence from both EPA and SCDHEC prior to publication of proposed plans and Record of Decisions (RODs). SCDHEC will be the designated oversight agency for review/approval of "RD/CM and CA/RA documents[2]" for the waste tanks systems identified in FFA Appendix B and oversight of all associated response action field activities. [WSRC-OS-94-42, Section IX.E.2.]

Operable Units (OUs) were created to address historical spill sites in both FTF and HTF not covered by Construction Permit #17,424-IW that may require response actions under the FFA. [WSRC-OS-94-42] These spill sites were previously listed on the FFA Appendix G (Site Evaluations List) by DOE at the time of the FFA approval and have subsequently been placed on Appendix C (RCRA/CERCLA Units List) as part of the FTF OU and the HTF OU for evaluation and possible remediation

Other OUs that are relevant are the GSA Western Groundwater OU beneath the FTF and the GSA Eastern Groundwater OU beneath the HTF (Figure 10.2-1). DOE is monitoring the groundwater in each OU under formal FFA-approved plans and submitting annual reports on groundwater quality until closure of the OUs. [ERD-EN-2005-0127, WSRC-RP-2000-4134] In the RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plans addressing the groundwater OUs, DOE, EPA, and SCDHEC have concluded that the most appropriate action is to continue to monitor the groundwater to ensure that surface water resources are adequately protected. [WSRC-RP-2003-4147, WSRC-RP-2000-4144] Investigations of the GSA Western and Eastern Groundwater OUs are ongoing. Final remedial decisions regarding these groundwater OUs will be timed with the clean-up of potential sources of groundwater contamination.

The FFA is currently based on a strategy that relies on an area-by-area cleanup to fulfill its requirements. Once the waste tank system removals from service are complete, a decision for the final area remediation of both the FTF and HTF OUs under the FFA can be established through a proposed plan and ROD. All proposed plans under the FFA are subject to review and comment by the EPA, SCDHEC, stakeholders, and the public; and approval by both the EPA and SCDHEC. A formal dispute resolution process is set forth in the FFA in case of disagreement on any actions to be taken.

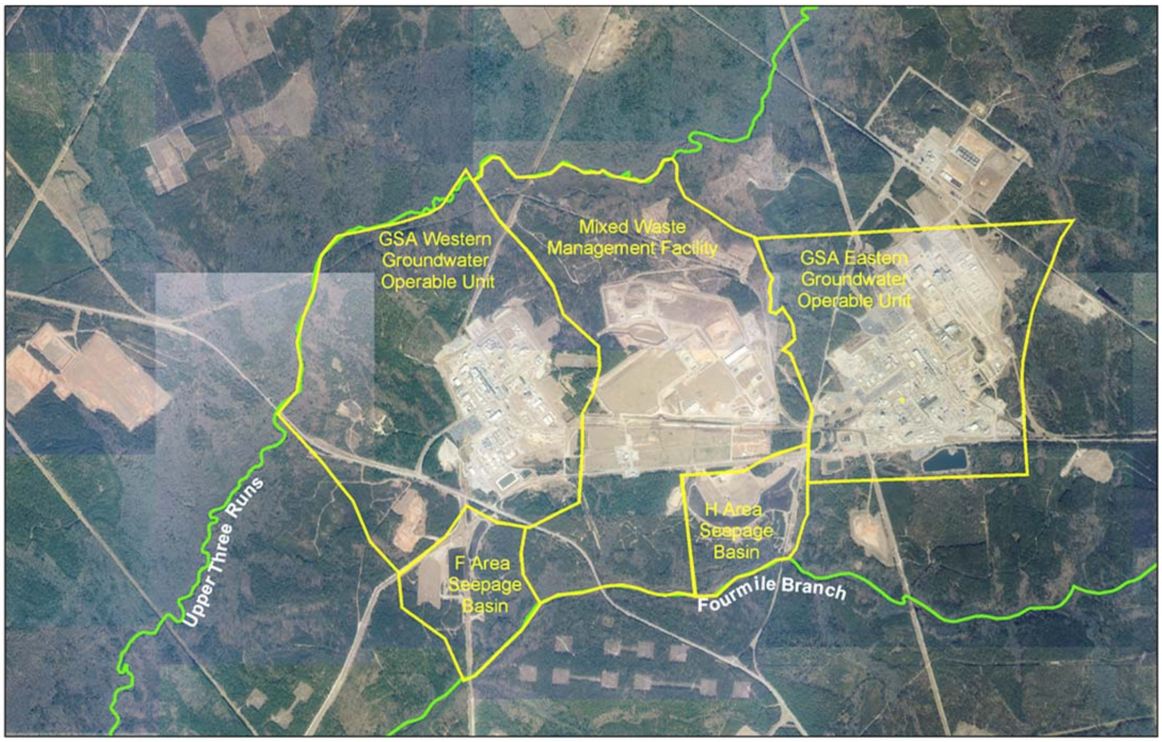
The FFA requires a review of the selected remedy every five years, consistent with 42 U.S.C. 9621(c), to ensure that human health and the environment are being protected by the selected

[2] Remedial Design/Corrective Measure and Corrective Action/Remedial Action documents

remedy. Should DOE, EPA, and SCDHEC conclude that additional action or modification of the remedy is appropriate; DOE will implement any additional response.

The FFA was designed and is being implemented in a manner that integrates multiple regulatory programs and facility activities into a cohesive and protective strategy. There are no regulatory gaps identified in the operation, closure, and long-term monitoring of the FTF and HTF.

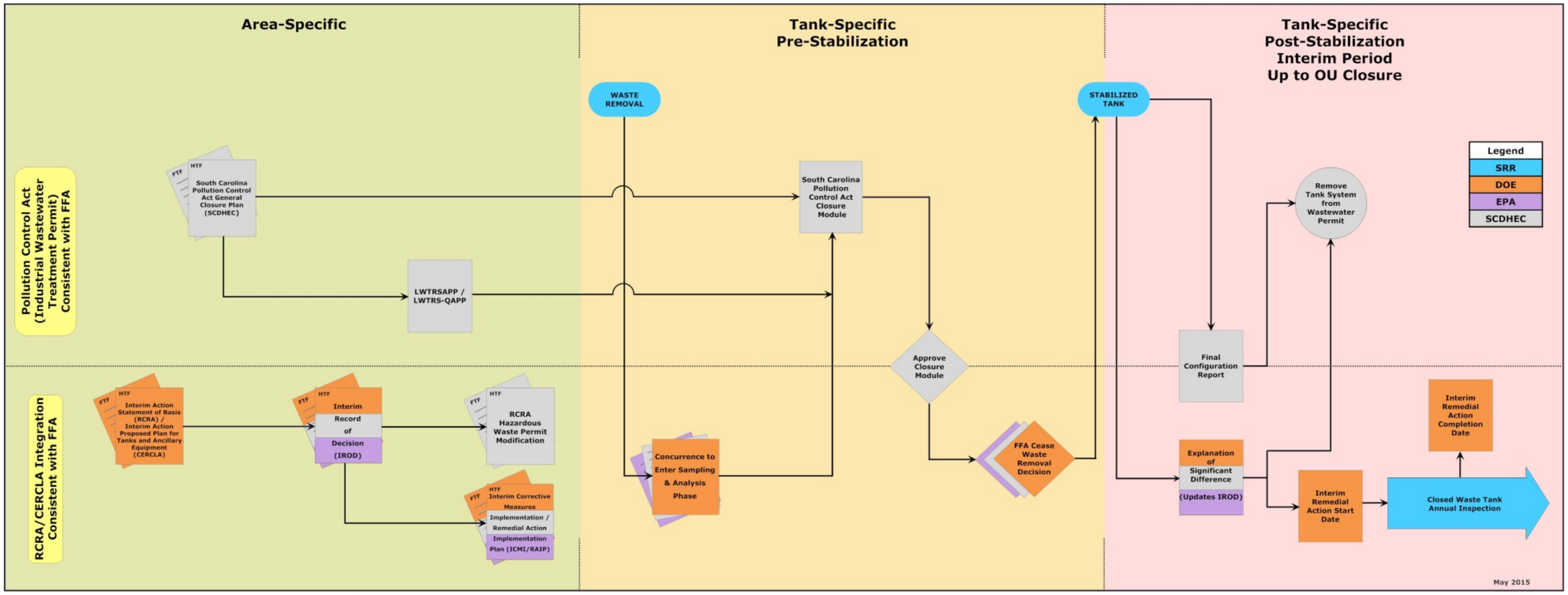
Figure 10.2-1: General Separations Area Groundwater Operable Units



10.3 Regulatory Documentation Pathway to Closure

Figure 10.3-1 depicts the integration of the documentation required for Construction Permit #17,424-IW and the RCRA/CERCLA integrated documentation consistent with the FFA. The documentation for individual waste tank system removal from service involves multiple agencies, each with specified criteria required to be demonstrated prior to taking removal from service actions. The results documented in the FTF and HTF PAs provide the foundation for future decision-making actions by all affected regulatory agencies. The PAs were developed to generate results needed to demonstrate that all of the performance objectives have been met. Some documents will provide closure information that is applicable to the entire FTF or entire HTF (i.e., area-specific documentation) and other documents will be specific to individual waste tank system closure activities.

Figure 10-3.1: Regulatory Documentation Path to Closure of the FTF and HTF under the Industrial Wastewater Requirements via the FFA



Note: After all waste tanks and ancillary structures in the FTF and HTF have been removed from service, final RODs will be issued for the FTF OU and the HTF OU in accordance with the FFA.

10.3.1 South Carolina Pollution Control Act Consolidated General Closure Plan

The SCDHEC has the authority to approve the PCA CGCP via Construction Permit #17,424-IW. This CGCP documents the process that will be employed for evaluating each waste tank system or group of waste tank systems within the FTF and HTF to determine if the cleaning and stabilization is protective of human health and the environment.

FFA Section IX.E addresses the eventual removal of waste tanks and ancillary structures from service and the final closure of the FTF and HTF. The FFA states that removal of waste tank systems from service must be performed in accordance with the PCA and all applicable regulations implementing that Act.

10.3.2 Interim Action Statement of Basis/Proposed Plan

The Interim Action Statement of Basis (IASB)/Proposed Plan (PP) purpose is to describe the preferred interim remedial alternative for the waste tanks systems that have been removed from service, and to provide for public involvement in the decision-making process. An IASB/PP was prepared for the first waste tank system closed in each tank farm. In FTF, the *Interim Action Statement of Basis/Proposed Plan for the F-Area Tank Farm, Waste Tanks 17 and 20* (SRR-CWDA-2011-00103) was prepared. In HTF, the *Interim Action Statement of Basis/Proposed Plan for the H-Area Tank Farm, Waste Tank 16* (SRR-CWDA-2015-00125) was prepared. DOE, SCDHEC, and EPA determined that an interim remedial action was needed for the waste tanks and ancillary structures removed from service to address the period between removal from the Construction Permit #17,424-IW until final closure of the OU. The interim action would ensure that the integrity of stabilization actions implemented under the general closure plans and system-specific closure modules were protected from significant damage or deterioration during the interim period. Each tank farm's IASB/PP also supports a tank farm-specific Interim Record of Decision (IROD) for the remedial alternative.

The remedial alternative, to conduct annual visible engineered barriers inspections and perform any maintenance necessary as a result of inspections, is the same for the FTF and HTF. The remedial alternative is applicable in the interim period until a final Remedial Action (RA) for each OU is determined.

10.3.3 Interim Record of Decision

The IROD for each tank farm presents and applies, by modifications, the selected interim RA of maintenance and monitoring of the engineered barriers for waste tank systems that have been removed from service.

10.3.4 Interim Corrective Measures Implementation/Remedial Action Implementation Plan

The Interim Corrective Measures Implementation (ICMI)/Remedial Action Implementation Plan (RAIP) provides for the implementation of the RA established in the IROD(s). The interim RA, annual visible engineered barriers inspection and maintenance, was selected for the FTF waste tank systems. [SRR-CWDA-2013-00048] The same interim RA was proposed in the ICMI/RAIP for the HTF waste tank systems and approved in November 2016. [SRR-CWDA-2016-00095]

10.3.5 Modification to the Resource Conservation and Recovery Act Hazardous Waste Permit

The Permit purpose is for the operation and post-closure care of hazardous and mixed-waste management facilities identified in the permit and identification and corrective action for Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) at SRS. The Permit is modified as needed to add the remedy selection for the associated tank farm to include the waste tank system that was removed from service. The modification is made by SCDHEC in conjunction with the EPA.

10.3.6 Concurrence to Enter Residuals Sampling and Analysis Phase

When DOE considers waste removal to be complete, DOE shall notify SCDHEC and EPA and provide any supporting documentation for review. If EPA and SCDHEC agree, they will independently provide letters of agreement to DOE. This agreement to proceed to the sampling and analysis phase is a non-binding preliminary decision and does not satisfy the requirements of FFA Appendix L, Requirement 9.b for demonstrating that waste removal activities may cease, as described in Section 6.3.

10.3.7 Closure Module

A system-specific CM detailing the actual inventory and removal from service configuration of individual waste tanks or group of tanks or associated ancillary structures will be submitted to SCDHEC for review and approval. The CM will be provided to EPA Region 4 project managers for review to ensure consistency with the FFA requirements for overall remediation of the FTF and the HTF.

Approval of the CM by SCDHEC and letters of agreement from SCDHEC and EPA constitute approval that FFA Appendix L, Requirement 9.b has been satisfied for the specified waste tank system addressed in the CM (see Section 11.2).

10.3.8 Completion of Waste Tank Stabilization

When the waste tank system has been stabilized with grout, as authorized by the approved CM and cease waste approval letters from SCDHEC and EPA, DOE will have met the FFA commitment for removal from service.

10.3.9 Explanation of Significant Difference

The purpose of an Explanation of Significant Difference (ESD) is to incorporate the closed waste tank system into the associated tank farm IROD. This action subjects the waste tank system to the RA listed in the applicable IROD.

10.3.10 Final Configuration Report

After an individual waste tank system is stabilized with grout, DOE will provide a Final Configuration Report (FCR) to SCDHEC describing the final configuration of that system. The report will include certification by a South Carolina professional engineer that all work has been completed in accordance with an approved closure plan and CM.

10.3.11 Waste Tank System Removal from Wastewater Permit

DOE will provide SCDHEC documentation that the closure activities have been successfully completed in accordance with the approved CM or approved CM Addendum, if necessary. The documentation may include, but not be limited to, video, photographs, work packages, and signed off work packages, as appropriate. After reviewing the documentation, SCDHEC will provide written verification that the waste tank system(s) have been removed from the conditions of Construction Permit #17,424-IW.

After all waste tank systems and ancillary structures in the FTF and the HTF have been removed from service; a series of RCRA/CERCLA documents required by the FFA will lead to a final ROD for the FTF and HTF OUs.

11.0 CLOSURE MODULE PREPARATION AND APPROVAL

Closure modules will be prepared to document the details associated with a waste tank system removal from service. Because the waste tank system removals from service will be a prolonged program, the opportunity will arise in future CMs to address and evaluate evolving technologies for waste removal, waste tank stabilization, and potential changes to regulations. The CMs also provide a mechanism for SCDHEC to review and approve each removal from service.

11.1 Closure Module Preparation

When SCDHEC, EPA, and DOE have mutually agreed that current waste removal activities may cease for the waste tank system being removed from service, and there is reasonable assurance that performance objectives can be met, the system will be visually inspected and sampled, as appropriate, to characterize the residual materials and a CM will be prepared. CM submittals could involve either the standard or alternate approach described below, or an appropriate variant determined in the future. In all cases, the approach used will be agreed upon by SCDHEC and DOE before the CM is prepared. All CM approaches could also be used in conjunction with either full or partial waste tank system isolation as described in Section 2.1.

The standard CM approach would use the actual (i.e., final) waste tank system inventory determined by residuals sampling and analysis to develop an SA that evaluates and provides reasonable assurance that the performance objectives will continue to be met for the associated tank farm closure and subsequent evaluation period. The standard CM will document the SA estimates for peak concentrations and peak dose for groundwater beneath the associated tank farm. When the standard approach CM is approved by SCDHEC, the DOE could proceed with closure activities in accordance with that CM.

The alternate CM approach involves two document review and approval steps. In the first step, a forecasted inventory is used for the performance objectives evaluation prior to the actual residuals characterization. The forecasted inventory would be an updated version of the waste tank system's assigned inventory from the applicable PA. The assigned inventory would be modified to include information associated with waste removal, process knowledge, inventories in previously closed or similar tanks, and adjustments to account for additional uncertainties. The forecasted inventory performance objectives evaluation would preliminarily evaluate and provide reasonable assurance that the performance objectives will continue to be met for the associated tank farm closure and subsequent evaluation period. The second step would be the submission of a CM Addendum with the actual (i.e., final) waste tank system inventory determined by residuals sampling and analysis and an SA that documents the peak concentrations and peak dose for groundwater beneath the associated tank farm using the final residuals inventory.

The alternate CM approach would be useful in circumstances when preparation and submission of the CM is necessary before the residuals characterization process is completed. The CM developed using the alternate approach could be conditionally approved by SCDHEC, but would not authorize DOE to proceed with irrevocable closure actions until the subsequent CM Addendum is approved by SCDHEC.

11.2 Closure Module Review, Approval, and Tracking

A waste tank system-specific CM and, if applicable, CM Addendum presenting the final residuals inventory and removal from service configuration will be submitted to SCDHEC for review and approval. It will also be provided to EPA Region 4 project managers for review to ensure consistency with the FFA requirements for overall remediation of the associated tank farm. If necessary, individual CMs will be written for the ancillary structures such as evaporators, diversion boxes, and pump pits if they are not included in a CM for the associated waste tank system.

SCDHEC would also provide the CMs, and if applicable, the CM Addendum, for public review and comment prior to SCDHEC approval. Each CM will be based on the process outlined in this CGCP. The individual CM, or CM and CM Addendum, would contain the documentation described in Section 11.3 for an individual waste tank system or group of systems to be removed from service.

A tracking table showing the CM/CM Addendum document numbers and the waste tank systems removal from service date will be included in the CMs. The example FTF and HTF waste tank systems tracking tables that will be included and updated in future CMs are shown in Tables 11.2-1 and 11.2-2. SCDHEC Construction Permit #17,424-IW will also be updated to officially record the waste tank systems removals from service.

Table 11.2-1: Example FTF Waste Tank Systems Removal From Service Tracking Table

Waste Tank System Listed in SCDHEC Construction Permit #17,424-IW	SRS Identifier[a]	Closure Module / Addendum Document Number	Removal from Service Date[b]
Tank 1	FL-241901-WTE-TK-1		
Tank 2	FL-241902-WTE-TK-2		
Tank 3	FL-241903-WTE-TK-3		
Tank 4	FL-241904-WTE-TK-4		
Tank 5	FL-241905-WTE-TK-5	SRR-CWDA-2012-00071	December 2013
Tank 6	FL-241906-WTE-TK-6	SRR-CWDA-2012-00071	December 2013
Tank 7	FL-241907-WTE-TK-7		
Tank 8	FL-241908-WTE-TK-8		
Tank 17	FL-241917-WTE-TK-17	PIT-MISC-0004	December 1997
Tank 18	FL-241918-WTE-TK-18	SRR-CWDA-2010-00003	September 2012
Tank 19	FL-241919-WTE-TK-19	SRR-CWDA-2010-00003	September 2012
Tank 20	FL-241920-WTE-TK-20	PIT-MISC-0002	July 1997
Tank 25	FM-241925-WTE-TK-25		
Tank 26	FM-241926-WTE-TK-26		
Tank 27	FM-241927-WTE-TK-27		
Tank 28	FM-241928-WTE-TK-28		
Tank 33	FL-241933-WTE-TK-33		
Tank 34	FL-241934-WTE-TK-34		
Tank 44	FM-241944-WTE-TK-44		
Tank 45	FM-241945-WTE-TK-45		
Tank 46	FM-241946-WTE-TK-46		
Tank 47	FM-241947-WTE-TK-47		
242-F (1F) Evaporator Pot	EP 41.20 (W230983)		
Condenser	EP 41.20-2 (W230983)		
Cesium Removal Column Pump Tank	EP 13-1 (W713707)		
Overheads Tank South	EP 42.20-1 (W231013)		
Overheads Tank North	EP 42.20-2 (W231013)		
Overheads Diverting Tank	EP 13-2 (W713707)		

Table 11.2-1: Example FTF Waste Tank Systems Removal From Service Tracking Table (continued)

Waste Tank System Listed in SCDHEC Construction Permit #17,424-IW	SRS Identifier[a]	Closure Module / Addendum Document Number	Removal from Service Date[b]
242-3F Concentrate Transfer System	EP 100 (W235849)		
242-16F (2F) Evaporator Pot	FM-242016-WEE-EVP-1		
Condenser	FM-242016-WEE-COND-1		
Mercury Collection Tank	FM-242016-WEE-TK-5		
Cesium Removal Column Pump Tank	FM-242016-WEE-TK-6		
Overheads Tank #1, South	FM-242016-WEE-TK-8		
Overheads Tank #2, North	FM-242016-WEE-TK-9		
FPP-1	FL-641000-IT-PPIT-1		
FPT-1	FL-641000-IT-TK-1		
FPP-2	FM-241021-WTS-PPIT-2		
FPT-2	FM-241021-WTS-TK-2		
FPP-3	FM-241021-WTS-PPIT-3		
FPT-3	FM-241021-WTS-TK-3		
FDB-1	FL-241002-WTS-DBX-1		
FDB-2	FL-641000-WTS-DBX-2		
FDB-3	FL-241077-WTS-DBX-3		
FDB-4	FM-241021-WTS-DBX-4		
FDB-5	FM-241033-WTS-DBX-5		
FDB-6	FL-241032-WTS-DBX-6		
F-Area Catch Tank	FL-241091-WTS-TK-1		

[a] Either the Smart Plant Component Location Indicator number or engineering drawing number showing the component.

[b] As used here, the *Removal From Service Date* is the DOE letter date documenting operational closure to SCDHEC and EPA.

Table 11.2-2: Example HTF Waste Tank Systems Removal From Service Tracking Table

Waste Tank System Listed in SCDHEC Construction Permit #17,424-IW	SRS Identifier[a]	Closure Module / Addendum Document Number	Removal from Service Date[b]
Tank 9	HL-241909-WTE-TK-9		
Tank 10	HL-241910-WTE-TK-10		
Tank 11	HL-241911-WTE-TK-11		
Tank 12	HL-241912-WTE-TK-12	SRR-CWDA-2014-00086 / SRR-CWDA-2015-00074	April 2016
Tank 13	HL-241913-WTE-TK-13		
Tank 14	HL-241914-WTE-TK-14		
Tank 15	HL-241915-WTE-TK-15		
Tank 16	HL-241916-WTE-TK-16	SRR-CWDA-2013-00091	September 2015
Tank 21	HL-241921-WTE-TK-21		
Tank 22	HL-241922-WTE-TK-22		
Tank 23	HL-241923-WTE-TK-23		
Tank 24	HL-241924-WTE-TK-24		
Tank 29	HL-241929-WTE-TK-29		
Tank 30	HL-241930-WTE-TK-30		
Tank 31	HL-241931-WTE-TK-31		
Tank 32	HL-241932-WTE-TK-32		
Tank 35	HL-241935-WTE-TK-35		
Tank 36	HL-241936-WTE-TK-36		
Tank 37	HL-241937-WTE-TK-37		
Tank 38	HM-241938-WTE-TK-38		
Tank 39	HM-241939-WTE-TK-39		
Tank 40	HB-241940-WTE-TK-40		
Tank 41	HM-241941-WTE-TK-41		
Tank 42	HB-241942-WTE-TK-42		
Tank 43	HM-241943-WTE-TK-43		
Tank 48	HI-241948-WTE-TK-48		
Tank 49	HI-241949-WTE-TK-49		
Tank 50	HI-241950-WTE-TK-50		
Tank 51	HB-241951-WTE-TK-51		
242-H (1H) Evaporator Pot	EP-1 (M-M6-H-1343)		
Condenser	EP-3 (M-M6-H-0227)		
Mercury Collection Tank	(M-M6-H-1645)		

Table 11.2-2: Example HTF Waste Tank Systems Removal From Service Tracking Table (continued)

Waste Tank System Listed in SCDHEC Construction Permit #17,424-IW	SRS Identifier[a]	Closure Module / Addendum Document Number	Removal from Service Date[b]
Cesium Removal Column Pump Tank	EP 13-1 (M-M6-H-1647)		
Overheads Tank #4	EP-4 (M-M6-H-1341)		
Overheads Tank #5	EP-5 (M-M6-H-1341)		
242-3H (Old) Concentrate Transfer System[c]	W238683		
242-18H (New) Concentrate Transfer System	EP 20-10-1 (W702921)		
242-16H (2H) Evaporator Pot	HM-242016-WEE-TK-3		
Condenser	HM-242016-WEE-HX-2		
Mercury Collection Tank	HM-242016-WEE-TK-7		
Cesium Removal Column Pump Tank	HM-242016-WEE-TK-8		
Overheads Tank #1	HM-242016-WEE-TK-5		
Overheads Tank #2	HM-242016-WEE-TK-6		
242-25H (3H) Evaporator Pot	HL-242025-WEE-EVP-1		
Condenser	HL-242025-WEE-COND-223		
Mercury Collection Tank	HL-242025-WEE-TK-311		
Overheads Tank #1	HL-242025-WEE-TK-1		
Overheads Tank #2	HL-242025-WEE-TK-2		
HPP-1[d]	HL-241035-WTS-PPIT-1		
HPP-2	HL-241035-WTS-PPIT-2		
HPT-2	HL-241035-WTS-TK-2		
HPP-3	HL-241035-WTS-PPIT-3		
HPT-3	HL-241035-WTS-TK-3		
HPP-4	HL-241035-WTS-PPIT-4		
HPT-4	HL-241035-WTS-TK-4		
HPP-5	HM-241070-WTS-PPIT-5		
HPT-5	HM-240170-WTS-TK-5		
HPP-6	HM-241070-WTS-PPIT-6		
HPT-6	HM-241070-WTS-TK-6		

Table 11.2-2: Example HTF Waste Tank Systems Removal From Service Tracking Table (continued)

Waste Tank System Listed in SCDHEC Construction Permit #17,424-IW	SRS Identifier[a]	Closure Module / Addendum Document Number	Removal from Service Date[b]
HPP-7	HG-241100-WTS-PPIT-7		
HPT-7	HG-241100-WTS-TK-7		
HPP-8	HG-241100-WTS-PPIT-8		
HPT-8	HG-241100-WTS-TK-8		
HPP-9	HG-241100-WTS-PPIT-9		
HPT-9	HG-241100-WTS-TK-9		
HPP-10	HG-241100-WTS-PPIT-10		
HPT-10	HG-241100-WTS-TK-10		
HDB-1	HL-241000-WTS-DBX-1		
HDB-2	HL-241035-WTS-DBX-2		
HDB-3	HL-241003-WTS-DBX-3		
HDB-4	HL-241008-WTS-DBX-4		
HDB-5	HL-241052-WTS-DBX-5		
HDB-6	HL-241056-WTS-DBX-6		
HDB-7	HM-241031-WTS-DBX-7		
HDB-8	HG-241100-WTS-DBX-8		
H-Area Catch Tank	HL-241909-WTS-TK-1		

[a] Either the Smart Plant Component Location Indicator number or engineering drawing number showing the component.

[b] As used here, the *Removal From Service Date* is the DOE letter date documenting operational closure to SCDHEC and EPA.

[c] Note: The transfer tank has been removed from the 242-3H Concentrate Transfer System.

[d] Note: HPP-1 did not have a pump tank.

11.3 Closure Module Content

The purpose of the CM is to present the waste removal and waste tank system cleaning history, the residuals characterization details, the final inventory associated with the residuals, and the SA results for the proposed removal from service. The CM would demonstrate that the proposed removal from service configuration is protective of human health and the environment and that the individual closure actions will continue to support meeting the applicable performance objectives for the closure of the entire associated tank farm.

If the alternate CM approach is used, the CM Addendum would present the final sampling details, sample analysis results, final residuals inventory, the SA result, and any new information affecting the removal from service decision.

In total, the CM, and CM Addendum if applicable, will typically contain the following elements:

Executive Summary – Summarizes the document content and conclusion(s).

Introduction – Defines the purpose and scope of the CM or CM Addendum. States the objectives to be met based on the most current applicable regulations.

Operational Service History – Provides a general description and operational history of the waste tank system being proposed for removal from service.

Waste Removal History – Presents the history of waste removal efforts for the waste tank system.

Residual Material Characterization – Presents the final residuals volume determination, analyte list development, and describes the residual material(s) sampling and analysis. If the alternate CM approach is used, this information would be provided in the subsequent CM Addendum.

Residual Waste Inventory – Presents the actual (or forecasted) residual material inventory used for the performance evaluation. If the alternate CM approach is used, the final inventory would be provided in the subsequent CM Addendum.

Performance Evaluation –An SA using the actual residuals inventory and the baseline fate and transport model from the associated PA would evaluate the estimated peak concentrations and peak dose expected in the groundwater beneath the associated tank farm. If the alternate CM approach is used, the SA based on the final residuals inventory would be presented in the CM Addendum.

Assessment of the Impact of Deploying Additional Technology – Assesses the possible impact to the final waste tank system condition if a different waste removal technology was implemented during the waste removal/closure process.

An evaluation will be provided to demonstrate that it is not technically practicable from an engineering perspective to continue with active waste removal activities. This analysis will include, but not be limited to, such things as technology capabilities, schedule impacts, and a quantified cost, risks, and benefit analysis.

Conclusion – Summarizes and confirms that the CGCP requirements have been met for the waste tank system removal from service.

11.4 Closure Module Development and Approval Process

The process depicted in Figure 11.4-1 and described below shows the roles, documents, and steps for the transitioning from the DOE briefing recommending cease waste removal to eventual removal from Construction Permit #17,424-IW.

This process will meet the requirements of the industrial wastewater permit issued by the SCDHEC, the requirements of the FFA (including FFA Appendix L, Requirement 9.b), and the mutual agencies agreement that waste removal activities may cease. [WSRC-OS-94-42]

As mentioned earlier, CM submittals could involve either the standard or alternate approach, or an appropriate variant determined in the future. In all cases, the approach used or approval path for any variant approach will be agreed upon by SCDHEC and DOE before the CM is prepared. The approval process for the standard and alternate CM approaches are described below.

11.4.1 Preliminary Cease Waste Removal and Isolation Decisions

- When DOE is satisfied that waste removal activities are sufficiently complete, a briefing will be provided to EPA and SCDHEC to present the preliminary waste removal data, the estimated remaining residuals volume, the plan to characterize the residuals, the initial isolation strategy, and whether the standard or alternate CM preparation approach will be used.
- Following the briefing, DOE will submit a letter to SCDHEC and EPA requesting concurrence that further waste removal is not technically practicable from an engineering perspective. SCDHEC and EPA will each provide a concurrence letter to DOE, preferably within 30 calendar days, to suspend active waste removal activities and to proceed to the sampling and analysis phase. DOE could then begin the residuals characterization process and start system isolation activities.

11.4.2 Preliminary Closure Module and Closure Module Addendum Development

DOE, SCDHEC, and EPA selection and agreement on either the standard or the alternate CM approach used for the waste tank system may rely on briefings and discussion of strategies to:

- Establish document review and approval schedules,
- Promote early and frequent interactions,
- Mutually resolve questions and issues related to waste tank system isolation, stabilization, closure, and
- Address specific areas or tasks related to waste removal, sampling and analysis, emerging issues, and schedule acceleration.

The meetings and briefings would be informal and proactive in addressing emerging issues that could impact the planned closure activities and schedule. Information would be freely distributed and discussed as needed between agencies to achieve the mutually beneficial objective of waste tank system closures.

Lessons learned during development and approval of previous CMs and CM Addendums may be used to streamline the process. Initial drafts of CMs and CM Addendums could be prepared either in total (i.e., all sections as described in Section 11.3) or in sub-groups of sections and provided for preliminary review.

The draft versions of documents will be submitted informally to SCDHEC and EPA for review. SCDHEC and EPA will send comments to DOE for resolution. DOE will disposition the comments, revise the draft documents, and maintain a comment response matrix.

The preliminary CM or CM Addendum development will conclude when all comments have been satisfactorily addressed and DOE provides Revision 0 of the CM and CM Addendum to SCDHEC ready for public review.

11.4.3 Standard Closure Module Approach and Approval Pathway

1. After the residuals are characterized and the final volume and inventory determined, a briefing would be given to EPA and SCDHEC to present the draft characterization data and SA results.
2. The CM Revision 0 would be submitted to SCDHEC. Within 15 days, SCDHEC would initiate a 30-day public review and comment period. Within 15 days following the end of the public comment period, SCDHEC would provide feedback to DOE on any changes needed as a result of public comments.
3. Within 30 days following the receipt of public comment feedback, DOE would make the changes and issue the CM Revision 1 to SCDHEC for approval. If no changes to Revision 0 are needed, DOE will resubmit the CM Revision 0 to SCDHEC for approval.
4. Within 30 days SCDHEC would review the CM Revision 1 for adequacy, and if appropriate, issue an approval letter to DOE for the CM. Coinciding with the CM approval date, a 15-day required "hold" period will begin to allow for the period between the SCDHEC staff decision and the SCDHEC final agency decision, before any irreversible closure actions (e.g., addition of grout into the waste tank system) can be performed by DOE.
5. At that time, and in accordance with FFA Appendix L Requirement 9.b, DOE would submit a letter to SCDHEC and EPA requesting concurrence on the final cease waste removal decision. SCDHEC and EPA would issue an FFA letter stating their final concurrence that all waste removal activities can cease and to document completion of FFA Appendix L Requirement 9.b.

Details on the waste tank system removal from the construction permit are presented in Section 11.4.5.

11.4.4 Alternate Closure Module Approach and Approval Pathway

A. When the alternate CM approach is used, a briefing would be given to EPA and SCDHEC to present the forecasted inventory, and results of the evaluation against the performance objectives using the forecasted inventory. A CM would be prepared containing the evaluation results and as much finalized waste tank system closure-related information as possible.

B. The CM Revision 0 would be submitted to SCDHEC. Within 15 days, SCDHEC would initiate a 30-day public review and comment period. Within 15 days following the end of the public comment period, SCDHEC would provide feedback to DOE on any changes needed as a result of public comments.

C. Within 30 days following the receipt of public comment feedback, DOE would make the changes and issue the CM Revision 1 to SCDHEC for approval. The CM Revision 1 could be conditionally approved by SCDHEC. Conditional approval would not authorize DOE to perform irrevocable closure actions, such as actual grouting of the waste tank system. If no changes to the Revision 0 are needed, DOE will resubmit the CM Revision 0 to SCDHEC for conditional approval.

D. After the residuals are characterized and the final volume and inventory determined, a briefing would be given to EPA and SCDHEC to present the final inventory and the SA results based on the final inventory. A CM Addendum Revision 0 containing the finalized information and the SA results would be prepared.

E. The CM Addendum Revision 0 would be submitted to SCDHEC. Within 15 days, SCDHEC would initiate a 30-day public review and comment period. Within 15 days following the end of the public comment period, SCDHEC would provide feedback to DOE on any changes needed as a result of public comments.

F. Within 30 days following the receipt of public comment feedback, DOE would make the changes and issue the CM Addendum Revision 1 to SCDHEC for approval. If no changes to Revision 0 are needed, DOE will resubmit the CM Addendum Revision 0 to SCDHEC for approval.

G. Within 30 days, SCDHEC would review the CM Addendum Revision 1 for adequacy, and if appropriate, issue an approval letter to DOE for the CM Addendum. Coinciding with the CM Addendum approval date, a 15-day required "hold" period will begin to allow for the period between the SCDHEC staff decision and the SCDHEC final agency decision, before any irreversible closure actions (e.g., addition of grout into the waste tank system) can be performed by DOE.

H. At that time, and in accordance with FFA Appendix L Requirement 9.b, DOE would submit a letter to SCDHEC and EPA requesting concurrence on the final cease waste removal decision. SCDHEC and EPA would issue an FFA letter stating their final concurrence that all waste removal activities can cease and to document completion of FFA Appendix L Requirement 9.b.

Details on the waste tank system removal from the construction permit are presented in Section 11.4.5.

11.4.5 Modification of the SRS Hazardous and Mixed Waste Permit and Industrial Wastewater Construction Permit for F-Area and H-Area Tank Farms

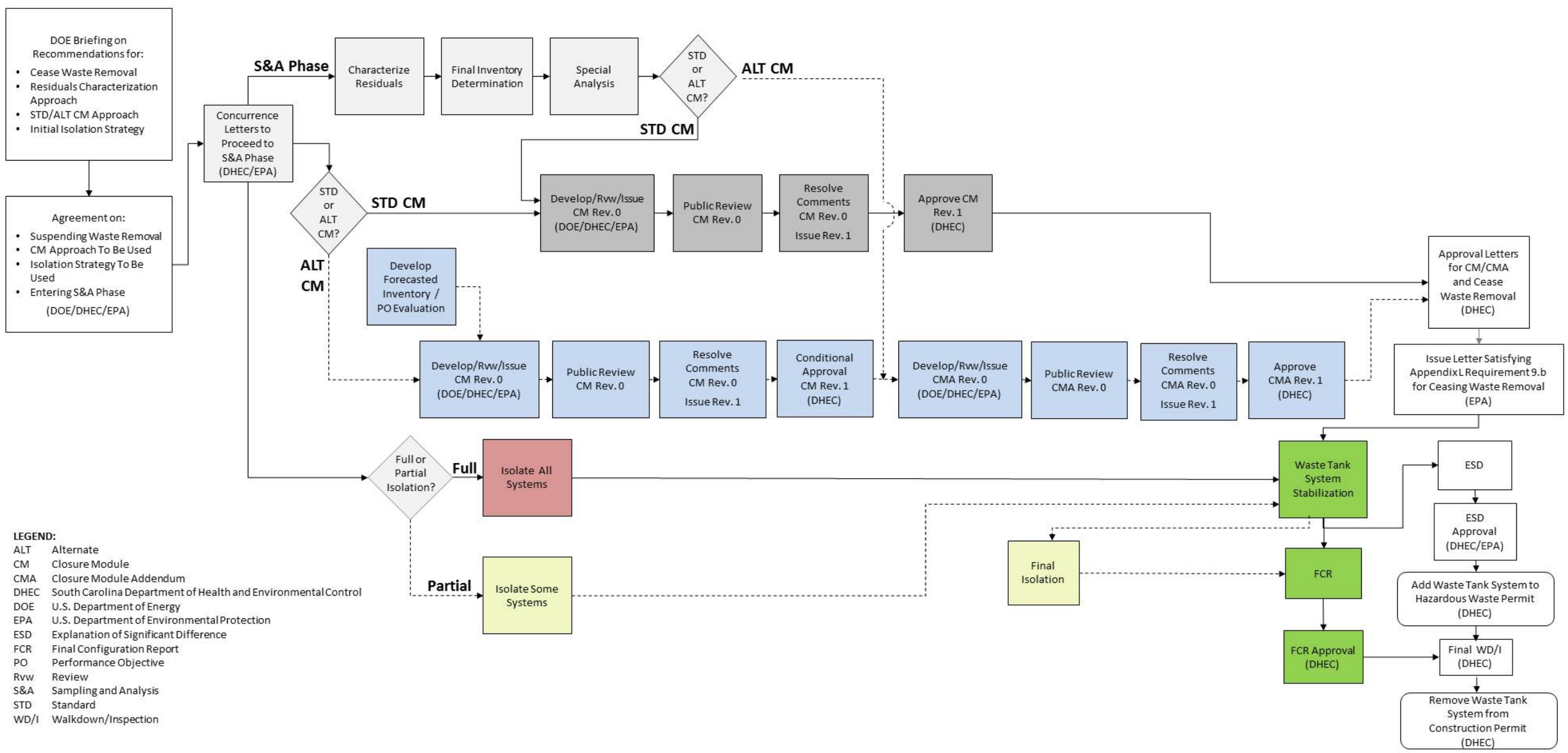
Following waste tank system stabilization, the FFA commitment for removal from service (i.e., operational closure) will have been met. Subsequently, DOE will begin development of the FCR and an ESD for the closed waste tank system.

The purpose of an FCR is to certify that work has been completed in accordance with the approved CGCP and associated CM and/or CM Addendum and document any differences encountered during stabilization. The ESD modifies the IROD for the associated tank farm and applies the selected remedy maintenance and monitoring controls to the waste tank system(s) that has been removed from service.

After the ESD is issued, SCDHEC in conjunction with EPA, will issue a modification to *SRS Hazardous and Mixed Waste Permit Number SC1 890 008 989*. [SCDHEC_2014] Specifically, SCDHEC updates Module VIII of the Corrective Action for Solid Waste Management Units & Areas of Concern, Appendix VIII-A, Solid Waste Management Unit Remedy Section to include the remedy selection for the specified waste tank system.

DOE will request a final inspection/walkdown of the closure activities by SCDHEC. After SCDHEC approval of the FCR, update of Appendix VIII-A, and SCDHEC has determined that the closure activities for the specific waste tank system are acceptable, SCDHEC will issue an approval letter for proper closure of the waste tank system. DOE will then request that SCDHEC remove the waste tank system from the tank farm permit. SCDHEC will provide a letter to DOE modifying Construction Permit 17,424-IW to show removal of the waste tank system from the permit.

Figure 11.4-1: Closure Module Approval and Waste Tank System Removal from Service Process



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ATTACHMENT 1: SRS WASTE REMOVAL PLAN and SCHEDULE for F-AREA and H-AREA WASTE TANK SYSTEMS, SRR-CWDA-2017-00014

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SRR-CWDA-2017-00014

Revision 1

SRS WASTE REMOVAL PLAN AND SCHEDULE for F-AREA and H-AREA WASTE TANK SYSTEMS

April 2017

Prepared by: Savannah River Remediation LLC
Waste Disposal Authority
Aiken, SC 29808

Prepared for U.S. Department of Energy Under Contract No. DE-AC09-09SR22505

INTRODUCTION

In support of environmental restoration activities at Savannah River Site, the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the South Carolina Department of Health and Environmental Control (SCDHEC) signed a Federal Facility Agreement (FFA) pursuant to Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Sections 3008(h) and 6001 of the Resource Conservation and Recovery Act (RCRA). The agreement became effective in August 1993. As part of this comprehensive agreement, DOE has committed to remove from service those liquid radioactive waste tank systems that do not meet the standards set forth in Appendix B of the FFA. Appendix B of the FFA also defines the specific waste tank systems that are subject to the agreement. The plan and schedule for this work is shown in FFA Appendix L. [WSRC-OS-94-42]

The *Consolidated General Closure Plan for F-Area and H-Area Waste Tank Systems* (SRR-CWDA-2017-00015) incorporates the current, approved FFA plan by reference and as an attachment. This *SRS Waste Removal Plan and Schedule for F-Area and H-Area Waste Tank Systems* document presents the most recent FFA Appendix L schedule as Table 1.

Should the schedule be amended pursuant to the process set forth in the FFA, with the agreement of SCDHEC (agreement not to be unreasonably withheld), DOE will provide a revised version of this waste removal plan and schedule document to SCDHEC and it will be considered a modification to the Consolidated General Closure Plan (CGCP). When the CGCP is revised, the current version of this waste removal plan and schedule document will be included.

Because revisions and issuance of this waste removal plan and schedule document and the CGCP will necessarily lag behind future FFA schedule amendments, please consult the latest revision of FFA Appendix L for the most current schedule.

REFERENCES

SRR-CWDA-2017-00015, *Consolidated General Closure Plan for F-Area and H-Area Waste Tank Systems*, Savannah River Site, Aiken, SC, Rev. 1, April 2017.

WSRC-OS-94-42, *Federal Facility Agreement for the Savannah River Site*, Savannah River Site, Aiken, SC, August 9, 2016.

Table 1: FFA Appendix L Schedule as of January 2017

Item	FFA Date	Milestone	Tank(s)	Completed
1	6/30/2009[a]	Additional waste removal efforts from Tanks 18 and 19	18F, 19F	4/2009
2	9/30/2010	Complete bulk waste removal (BWR) efforts for 2 tanks	8F, 12H	9/2010
3	9/30/2011	Complete BWR efforts for 1 tank	11H	5/2011
4	9/30/2014	Complete BWR efforts for 2 tanks	4F 7F	6/2011 (4F) 8/2011 (7F)
5	10/31/2017[b] 8/31/2018[b]	Complete BWR efforts in Tank 15H Complete BWR efforts in Tank 10H	15H 10H	--
6	9/30/2017	Complete BWR efforts for 3 tanks	--	--
7	9/30/2018	Complete BWR efforts for 6 tanks	--	--
8	9/30/2019	Complete BWR efforts for 1 tank	--	--
10	12/31/2012	Complete operational closure of Tanks 18 and 19	18F, 19F	9/2012
11	9/30/2015 9/30/2015[c] 10/27/2015[c] 5/31/2016[c]	Complete operational closure of 2 tanks Complete field activities in preparation of grouting Complete operational closure of 1 tank Complete operational closure of 1 tank	5F, 6F 12H 16H 12H	9/2013 9/2015 9/2015 4/2016
12	9/30/2017	Complete operational closure of 2 tanks	--	--
13	9/30/2019	Complete operational closure of 2 tanks	--	--
14	9/30/2021	Complete operational closure of 5 tanks	--	--
15	9/30/2022	Complete operational closure of 7 tanks	--	--
16	8/31/2008	FTF PA Revision 0 to SCDHEC	FTF	8/2008
17	3/31/2011	HTF PA Revision 0 to SCDHEC	HTF	3/2011

[a] Per extension request approved – 1/2009

[b] Per resolution of informal dispute – 12/2016

[c] Per resolution of formal dispute – 4/2015

-- = To be determined