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3116 Determination Scoping Document for the 242-F Evaporator System and Tanks 17 – 20 Related Transfer Lines

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LIST OF ACRONYMS

ALARA	As Low As Reasonably Achievable
BCP	Baseline Change Proposal
CRC	Cesium Removal Column
Cs-137	Cesium-137
CTS	Concentrate Transfer System
DOE	Department of Energy
DWPF	Defense Waste Processing Facility
EPA	Environmental Protection Agency
FFA	Federal Facility Agreement
FTF	F-Tank Farm
GCP	General Closure Plan
GDL	Gravity Drain Line
gpm	Gallons Per Minute
HA	Hazard Analysis
HLW	High-Level Waste
HTF	H-Tank Farm
kgal	Thousand Gallons
MEP	Maximum Extent Practical
NDAA	National Defense Authorization Act
NRC	Nuclear Regulatory Commission
PODD	Performance Objective Demonstration Document
psi	pounds per square inch
PUREX	Plutonium Recovery and Extraction
QA/QC	Quality Assurance/Quality Control
SCDHEC	South Carolina Department of Health and Environmental Control
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
WSMS	Washington Safety Management Solutions
WSRC	Washington Savannah River Company

1.0 EXECUTIVE SUMMARY

The purpose of this document is to identify the activities necessary to meet the requirements of Section 3116 of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA) for closure of the 242-F Evaporator Systems and the Tanks 17-20 related transfer lines.

This scoping document describes the historical waste removal activities, including the waste removal, sampling, characterization, and performance assessment modeling associated with the 242-F Evaporator System (this includes the Evaporator, the North and South Overheads tanks, the Concentrate Transfer System, and their related containments) and with the Tanks 17-20 related transfer lines. Additionally, this scoping document describes further details to meet specific Section 3116 objectives. This document addresses those remaining activities to meet the requirements of 3116 that include Class C concentration limits, performance objectives, and removal of waste to the maximum extent practical (MEP). Preliminary Cost/Risk-Benefit analyses have been evaluated against a number of possible alternatives to accomplish this task.

A Project Team will be formed after approval of a Baseline Change Proposal (BCP) by the Department of Energy (DOE) authorizing closure activities per the 3116 legislation for the 242-F Evaporator System and the Tanks 17-20 related transfer lines.

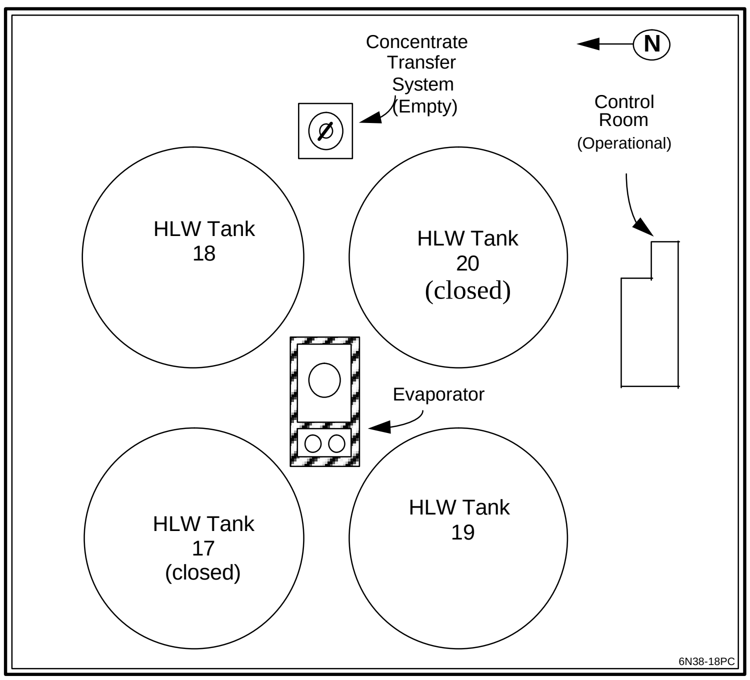
2.0 SYSTEM DESCRIPTION AND OPERATIONAL HISTORY

The Savannah River Site (SRS) currently stores approximately 36 million gallons of high-level waste in underground tanks in the F- and H- Areas near the center of the site. Interconnections, or transfer lines, connect high-level waste storage tanks and ancillary equipment. Ancillary equipment associated with waste tank systems provides mechanisms for waste processing (treatment) capabilities, volume reduction capabilities and capabilities for transfer to the Defense Waste Processing Facility (DWPF) for solidification of wastes. DOE is committed to remove from service those high-level waste (HLW) tank systems that do not meet the standards set forth in Appendix B of the SRS Federal Facility Agreement (EPA, 1993). After wastes are removed from individual tank systems, they will be closed under South Carolina Regulation R.61-82, "Proper Closeout of Wastewater Treatment Facilities" and then removed from the industrial wastewater permits that regulate their operation. Tanks 17 and 20 of F-Tank Farm are closed and Tanks 18 and 19 are in the review and approval process for closure. South Carolina Department of Health and Environmental Controls (SCDHEC) permitted the 242-F Evaporator as an industrial wastewater treatment facility under Construction/Operating Permit No. 17,424-IW (Sadler, 1993). The 242-F Evaporator is no longer in service and closure is planned.

2.1 Operational History of the 242-F System and Tanks 17-20

As depicted in Figure 2-1, Tanks 17, 18, 19 and 20 and the 242-F Evaporator System are a logical grouping for closure purposes. Tanks 17 and 20 have already been closed. Heel removal and isolation for Tanks 18 and 19 has been completed, and the tanks are ready for operational closure pending the outcome of the Draft 3116 Determination and the SCDHEC review and approval of the Tank 19/18 Industrial Wastewater closure module for closure of these tanks. The 242-F Evaporator System is no longer in service and is planned for closure.

Figure 2-1: General Layout of the Tanks 17-20 Grouping



2.1.1 242-F Evaporator System

The 242-F Evaporator System was used to reduce the amount of liquid volume of high-level radioactive waste resulting from nuclear processes. The Evaporator System is comprised of the Evaporator, the Overheads System, the Condenser, and the Concentrate Transfer System (CTS) (see Figures 2-2 through 2-8). The CTS is a pump tank that was used to distribute evaporator bottoms throughout the F-Tank Farm. Reducing the liquid volume requires fewer storage tanks. During its lifecycle, the 242-F Evaporator system received Plutonium Recovery and Extraction (PUREX) waste and non-canyon waste.

The 242-F Evaporator facility was constructed and placed into service in 1960. The evaporator was designed for a throughput of supernate of 9 gallons per minute (gpm). Waste was concentrated via evaporation by removing excess water and releasing overheads to the F-Area Seepage Basin. During operation, the waste tanks received waste from the 221-F canyon for aging. Aging allowed separation of the sludge and supernate and also allowed the shorter-lived radionuclides to decay. The resulting supernate was pumped to the evaporator feed tank. Supernate in the evaporator was boiled using steam at 150 pounds per square inch (psi) and separated into overheads and concentrated liquid. The separation of the overheads from the supernate reduced the supernate volume to about 25% to 30% of original volume. The concentrate from the evaporator was steam lifted to the CTS to prevent the concentrate from forming salt formations and solidifying in the system. The CTS draw-off pump circulated the concentrate continuously through a loop line to the concentrate receipt tanks. Various tanks have served as concentrate receipt tanks over the process lifecycle. When concentrate reached a predetermined level in the CTS tank, a drop valve opened to add concentrate to a receipt tank. The overheads exited the evaporator as vapor via a de-entrainment column and entered the condenser, a small scale heat exchanger. The overheads were cooled by well water in the condenser. The overheads then entered the mercury removal tank where mercury in the overheads settled to the bottom of the removal tank for dispositioning. The overheads were piped to the cesium removal column (CRC) pump tank for cesium removal. The CRC column typically contained about 70 gallons of zeolite resin.

Figure 2-2: 242-F Evaporator Facility Elevation Schematic

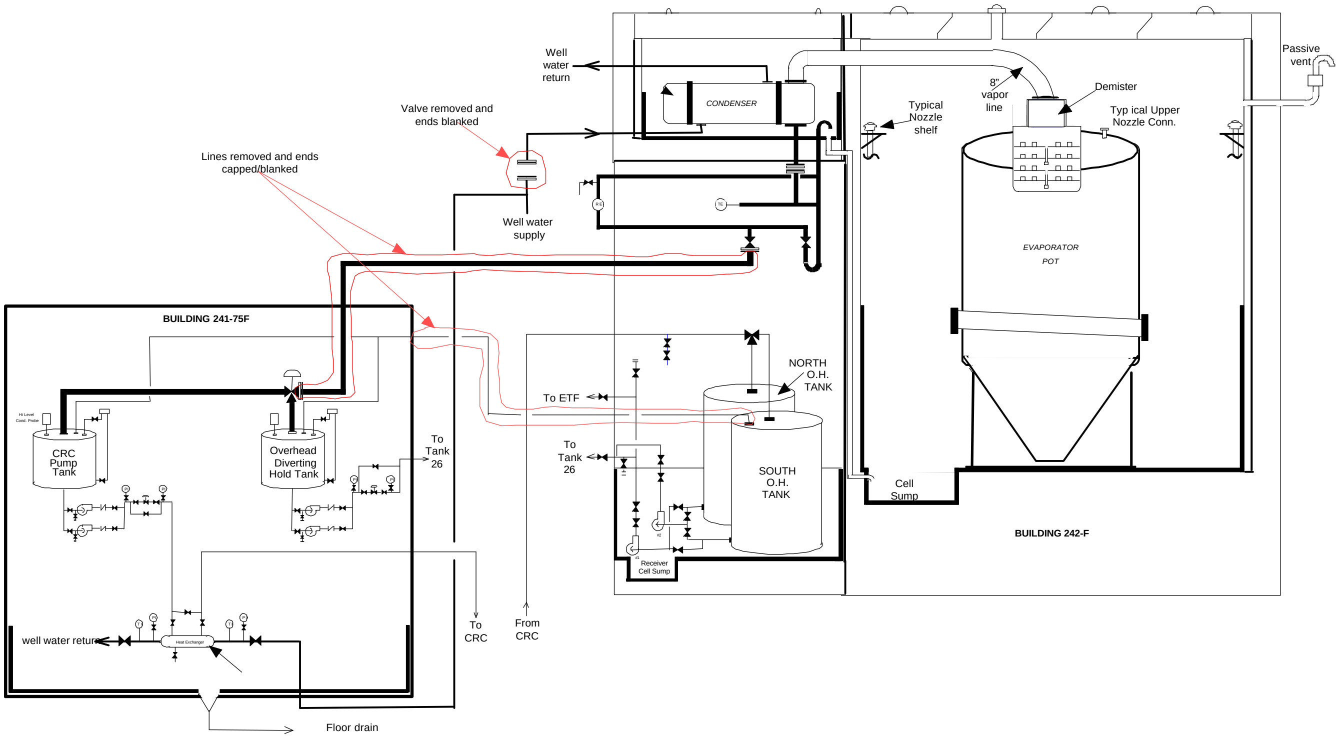


Figure 2-3: Photograph of 242-F Evaporator (Looking from the Northeast)

Figure 2-4: 1F Evaporator Vessel (Top View)

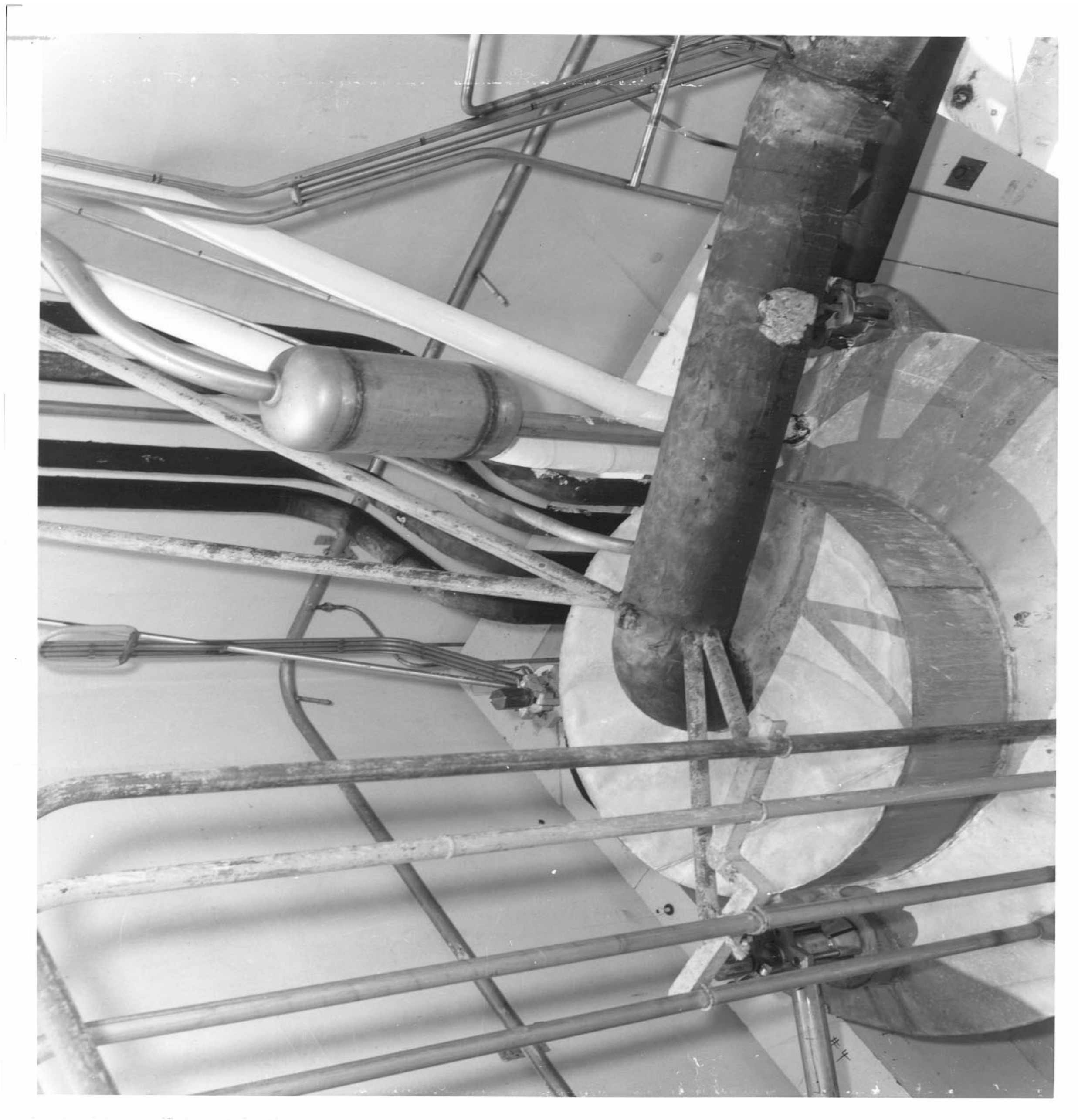


Figure 2-5: 242-F Evaporator West Side: Receiver Cell

Figure 2-6: Overheads Tank

Figure 2-7: Schematic Representation of the 242-F Evaporator System

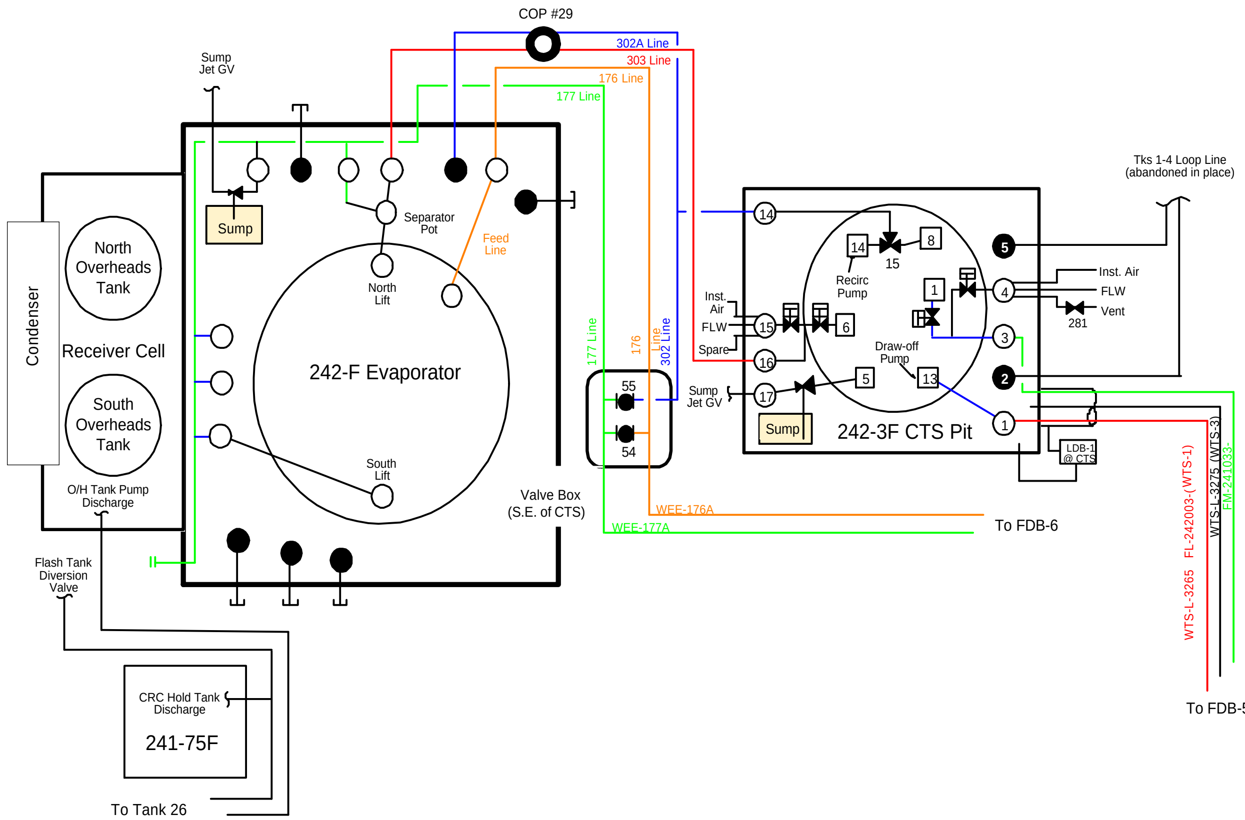
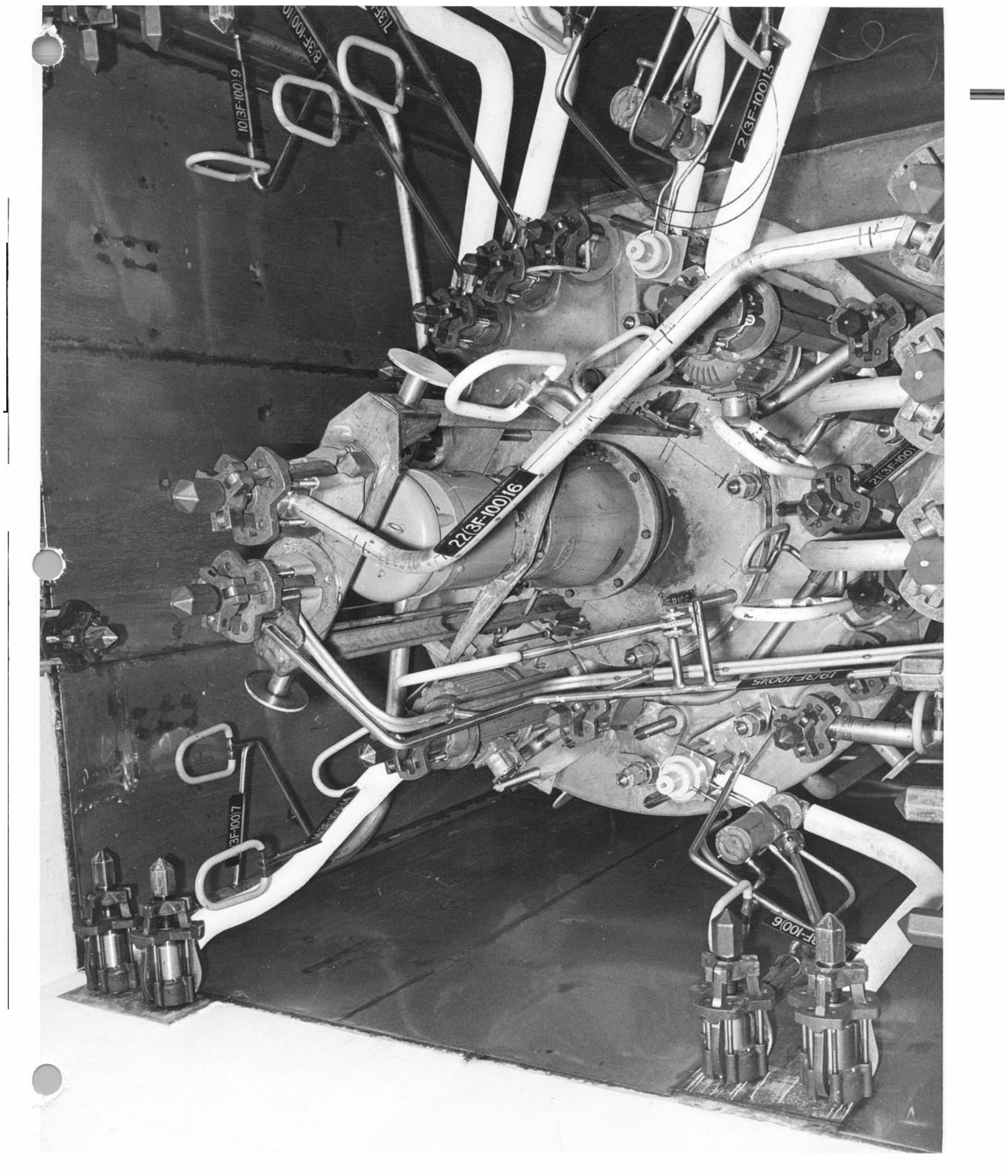


Figure 2-8: CTS Pit and Tank



2.1.1.1 242-F Evaporator System Removed From Service

After a desalt and de-scale effort was performed on the evaporator in 1988, the 242-F Evaporator System was removed from service. Following system lay-up in 1988, the 242-F Evaporator System was emptied and flushed. Water and inhibitors were added to the evaporator pot with the resultant solution being used to flush the CTS tank. The procedure employed to desalt and de-scale the evaporator, Procedure 241-FH-323Q, required flushing the evaporator pot until the specific gravity of the last flush batch was below 1.10. In the late 1991-early 1992 time frame, this process was repeated prior to reclassification of the 242-F Evaporator System as an "inactive process area" under the then current safety basis documents. Since then, the CTS tank has been used as a catch tank for rainwater collection, a non-waste processing function. The current Safety Basis implemented in April 2003 documents that the 242-F and 242-3F facilities (i.e., the 242-F Evaporator System), have been removed from service.

As part of the strategy for closing waste tank handling facilities, the 242-F Evaporator System was re-evaluated with more waste materials being removed in CY 2004. The scope for this latest waste characterization and removal effort was to develop a more detailed evaluation of the remaining waste materials in the individual components of the 242-F Evaporator System and attempt to remove additional waste from these individual components, where necessary. These components include the 242-F receiver cell, North and South Overheads tanks, 242-F evaporator cell and evaporator vessel, and 242-3F CTS tank. The equipment relative to the evaporator system includes:

1) Evaporator Pot – The evaporator pot, located inside the 242-F evaporator cell (242-F facility), is a stainless steel cylindrical vessel with a cone bottom. The cylindrical portion is 8' in diameter and 8'-9¾" high. The cone has a maximum diameter of 8' and is 5'-11" in height. The evaporator was used to concentrate liquid in order to reduce waste volumes.

2) Evaporator Cell – The evaporator cell is a cuboid with a 16' x 15' base and a height of 25'. The cell includes a floor sump measuring 2' x 2' x 2'-6" deep. The cell provided containment for the evaporator and served as shielding for personnel protection. The cell includes a stainless steel liner.

3) Receiver Cell – The receiver cell is a cuboid with a 15' x 9'-8" base and a height of 6'-4". The receiver cell includes a floor sump with a 1'-6" x 1'-6" base x 1'6" depth. The receiver cell provided containment for the two Overheads Vessels.

4) North and South Overheads Tanks – The Overheads Tanks, located inside the 242-F Receiver Cell, are each cylindrical stainless steel vessels having a diameter of 6' and a height of 6'. The Overheads tanks functioned as receipt tanks for liquids condensed from evaporator vapors.

5) Condenser – The condenser is a stainless steel cylindrical vessel with an outer diameter of 18” and a height of 9’-10.25”. The condenser functioned to condense evaporator vapors into liquid, which was drained to the North and South Overheads tanks.

6) CTS tank – The stainless steel tank, located inside the 242-3F CTS Pit, is a cylindrical vessel with a diameter of 8’ and a height of 8’-4”. The CTS tank functioned as a pump reservoir for transferring concentrated waste received from the evaporator to underground storage tanks within the F Tank Farm.

7) CTS Pit – The CTS Pit is a cuboid having a 12’ x 12’ base x 21’ height. The pit includes a floor sump having a 1’-6” x 1’-6” base x 1’-6” depth. The CTS Pit provided containment for the CTS tank and featured a stainless steel liner. Cell covers provided personnel protection.

The volumes for these components are listed in Table 2-1.

Table 2-1: Summary Table of 242-F Evaporator System Volumes

242-F Evaporator System Components	Volume ($feet^3$)
242-F Condenser Cell	806
242-F Condenser	16*
242-F Evaporator Cell	6400
242-F Evaporator	590*
242-F Receiver Cell	925
242-F N. Overhead Tank	175*
242-F S. Overhead Tank	175*
242-3F Pit	3025
242-3F Tank	400*
Totals	~11400

*Included in respective containment volume.

2.1.1.2 242-F Evaporator System 2003-2004 Waste Removal Campaign

Most of the wall area in the 242-F evaporator and CTS tank exposed to radioactive material had been previously washed via the flushing cycles during the 1988 and 1991/92 waste removal efforts. The 242-F Evaporator System Closure Project continued these previously completed cleaning strategies in accordance with identified decommissioning alternatives developed by Washington Safety Management Solutions (WSMS) (Tesch, 2001). The 242-F Evaporator System Project’s Team Execution Plan (TEP, 2004) proposed using the WSMS-identified Clean and Stabilize Alternative; therefore, the project team removed liquid heels and flowable solids, inspected for and sampled residual solids, characterized volumes of any residual solids, and developed groundwater modeling.

During the November 2003 heel removal campaign, various mixing and transfer cycles were completed. Both the North and South Overheads tanks were re-circulated before their contents were transferred to Tank 26. Video inspection (Waltz and West, 2003; Waltz and West, 2004a: Waltz and West, 2004b) of the 242-F receiver cell confirmed the absence of solid process wastes, i.e., “sludge”. Considerable debris remains in the receiver cell, including hard hats, tapes, conduit, etc. These miscellaneous items are consistent with past practices for facilities of this nature and do not represent a radiological issue for performance assessment dose calculations.

Process design precluding a normal path for process solids waste entering the condenser, boroscope camera inspection of the 242-F Condenser, and process history showing no identified incidence of solid process waste entering the condenser were used to support the conclusion that the condenser vessel is free of solid process waste.

Video inspection (Waltz and West, 2003) of the south overhead tank revealed a granular material residue or non-process waste sediment (Swingle, 2004a), sloping from 2 to 12 inches across the floor of the tank (see figure 2-9). Inspections (Waltz and West, 2003; Waltz and West, 2004b) indicated <2 inches of this material is in the north overheads tank (see figure 2-10). The North Overheads tank is estimated to contain ~14 gallons of this material, the South Overheads tank ~98 gallons. The material was subsequently sampled and identified as zeolite (Swingle, 2004a and b). Zeolite resin was received from the 242-F evaporation process via an ion-exchange column. During the evaporator concentration process, the excess water that is removed is known as overheads. The overheads contain a minimal concentration of radioactive constituents from the evaporation process. The liquid overheads were treated with an ion exchange column that contained a resin commonly known as zeolite. The ion exchange column, also known as the Cesium Removal Column (CRC), was located on the Tank 19 Northeast Riser. The Tank 19 CRC was designed to remove Cesium-137 (Cs-137) from the overheads stream. The spent zeolite resins and the captured Cs-137 were directly discarded into Tank 19 from 1964 until 1984. Approximately, 13 thousand gallons (kgal) of “spent” zeolite from the CRC were discarded into Tank 19. Evaporation operations dewatered liquid waste out of Tank 19 during these approximately 20 years with minor amounts of discarded zeolite in Tank 19 going through the evaporator system process and being deposited into the overheads tanks.

During the May-July 2004 heel removal campaign, various mixing and transfer cycles were completed from the CTS Vessel. Contents of the CTS tank (see figure 2-11) were slurried and pumped to the CTS sump and subsequently transferred to Tank 26 via the north overheads tank and pump. Part of this transferred material included flush water added to the tank and pit for dose rate mitigation during isolation activities.

Figure 2-9: Video Inspection of the South Overheads Tank

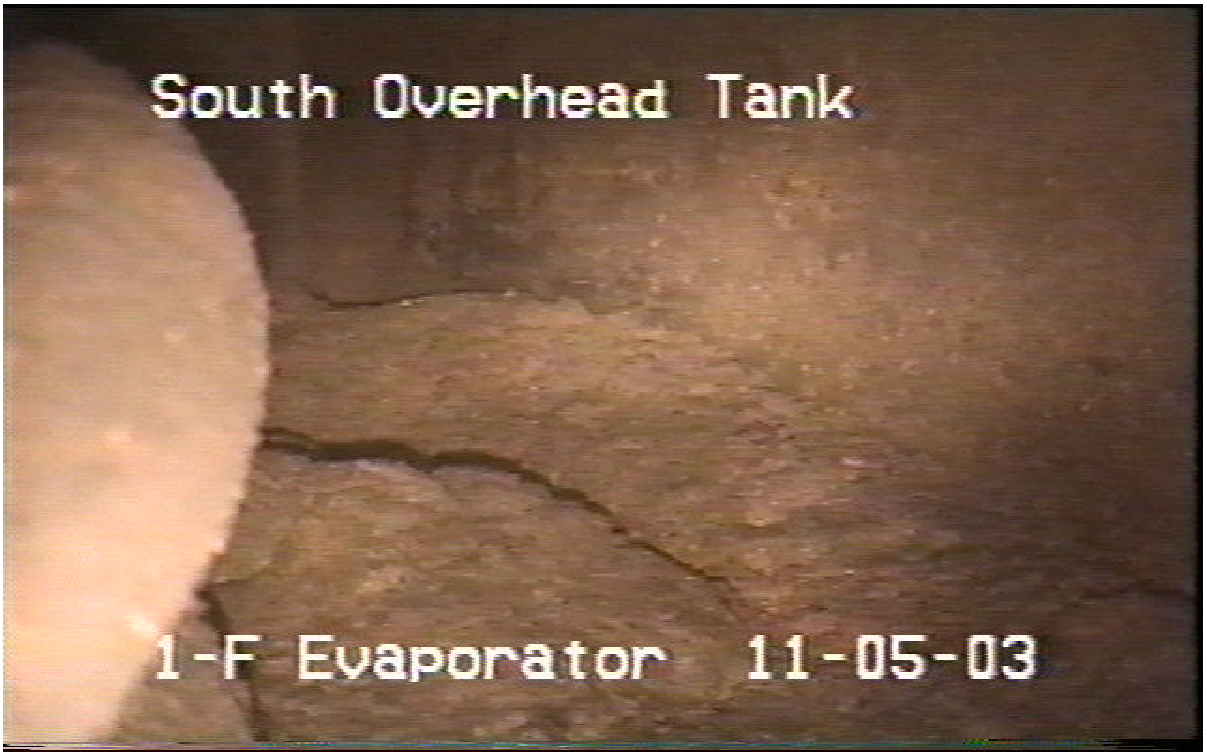
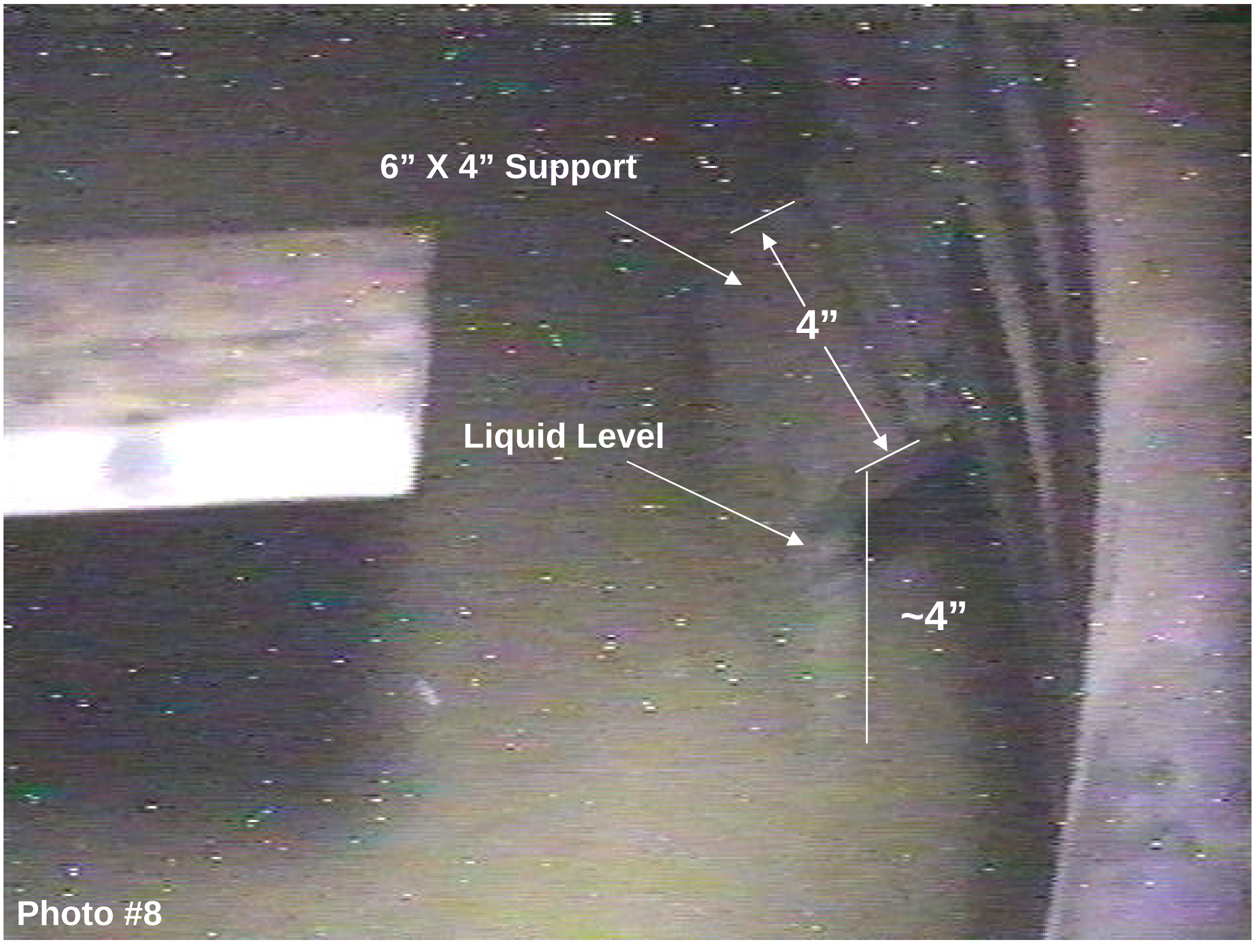


Figure 2-10: Video Inspection of the North Overheads Tank

Figure 2-11: CTS Tank Internals



Video inspection (Waltz and West, 2003; Waltz and West, 2004a) of the 242-3F CTS Pit confirms the absence of solid process waste within the cell (see figure 2-12), (Waltz, 2004c). No solid waste was observed on the interior pit walls, pump tank exterior, floor sump or piping. Some operational/maintenance debris such as retired jumpers, connector heads, hard hats, and mud (well water sediment) was evident. There was no evidence of radioactive process waste materials.

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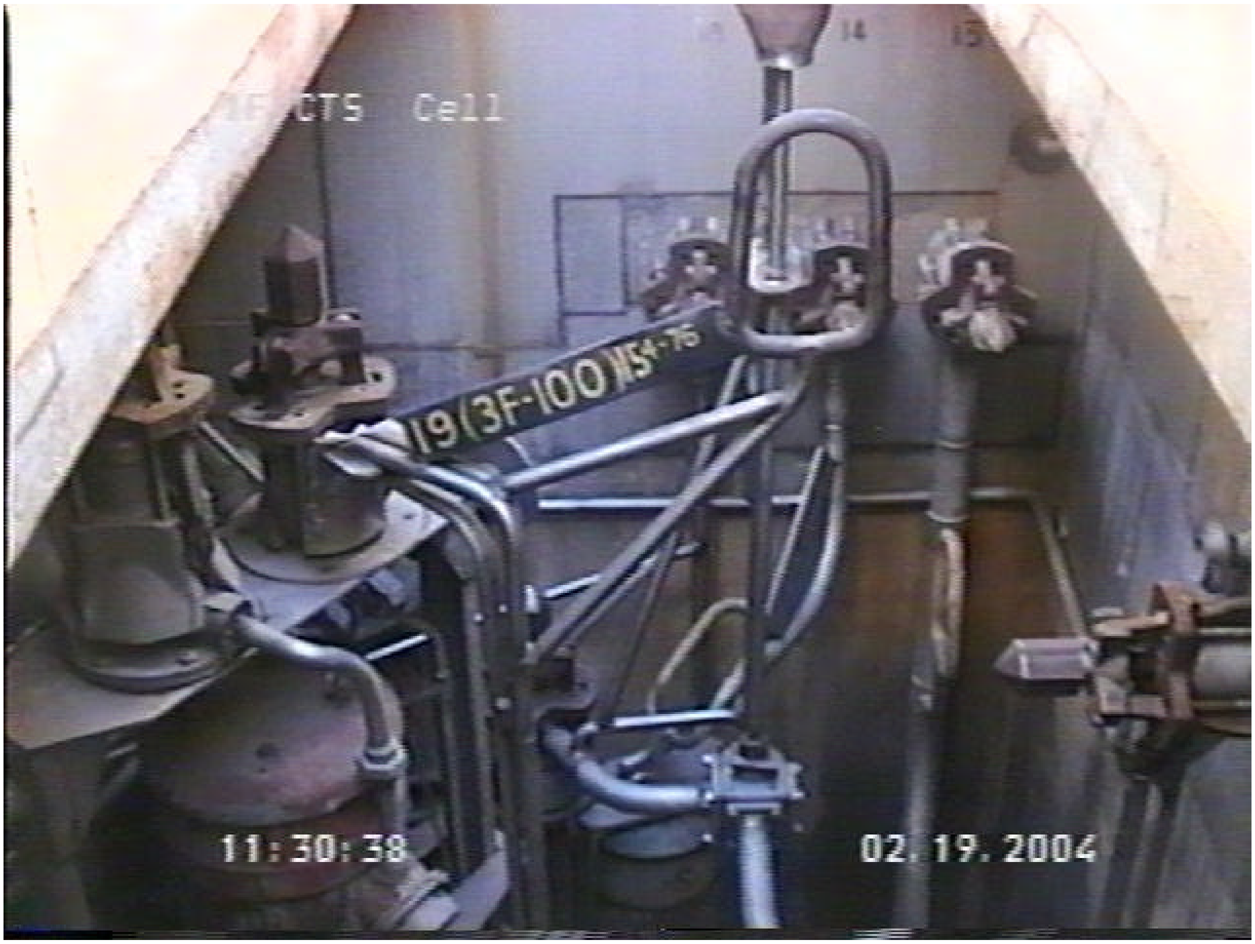
Figure 2-12: CTS PIT Internals



Video inspection of the interior of the CTS Vessel was performed and evaluated (Waltz, 2004). No solid waste was observed on the interior tank walls, steam coils, or pump externals; however, minor scale was identified. A very thin scale was observed on the warming coil, and a ~2" layer of coarse sediment was evident at the bottom of the tank. Video-based estimates placed the volume of this sediment at ~90 gallons (Waltz, 2004b).

During the April-May 2004 heel removal campaign, various mixing and transfer cycles were completed from the 242-F evaporator. Contents of the evaporator pot were slurried and pumped to the 242-F cell sump and subsequently transferred to Tank 26 via the north overheads tank and pump. Approximately 900 gallons of existing contaminated rain and flush water that had collected in the 242-F and 242-3F sumps was also transferred to Tank 26 during batch processing through the north overheads tank.

Video inspection (Waltz and West, 2002; Waltz and West, 2004a) of the 242-F evaporator cell confirmed the absence of sludge waste; however, salt was known to have migrated to the 242-F cell sump. The salt was associated with leaking tank connectors where salt had accumulated on the exterior of the tank and/or connectors. The interior of the 242-F evaporator cell has been subject to rainwater in-leakage through the cell covers for a number of years and must be periodically pumped. Results from samples obtained from the evaporator cell in 1998 permitted transfer of the cell contents to Tank 18 under contaminated rainwater requirements in the then-approved safety basis. Remaining in the cell is considerable debris, including hard hats, tapes, Hanford connector components, conduit, spent process jumpers, etc.

Video inspection (Waltz and West, 2002) of the 242-F evaporator vessel (see figures 2-13 through 2-15) indicated that conditions of the vessel appeared consistent with normal operations including vessel flushing. Discoloration in the vessel and liquid level marks on the vessel wall are normal with no unusual conditions noted. The inspection indicated the presence of ~300 gallons of residual flush water and less than 1 gallon of unsuspended silt-like material, i.e., highly mobile sediment. During the heel removal campaign, the total volume of free liquid was reduced from ~300 gals to 30 gallons. The solids volume removed is estimated to be a similar reduction of 90%; however, the estimated residual solids volume was conservatively increased by a factor of 3 (i.e., 0.1 gallons $\times$ 3 = 0.3 gallons) as no direct visual measurement was available (Waltz and West, 2004b). A sampling program for the remaining residual solids was developed for the South overheads tank, evaporator vessel and CTS tank.

Figure 2-13: 242-F Evaporator Tube Bundle

The South overheads tank sample was collected directly using a scoop or sample vial scrape attached to the end of a flex rod. Radiochemical analysis of the sample indicated the sediment was zeolite.

The evaporator vessel sample was collected during heel removal. A mixing pump was installed directly into the bottom of the evaporator vessel where less than 1 gallon of silt/sediment had been previously identified. A heel removal pump with a separator screen placed on the discharge line was installed. The mixing and heel removal pumps were operated simultaneously. Video review during the heel removal demonstrated mixing pump efficacy. At the completion of heel removal, the separator was removed and the contents transported to SRNL for radiochemical analysis.

The CTS tank sample was collected using the same equipment arrangement as that used for the evaporator. A sample of solids was collected and provided to the Savannah River National Laboratory (SRNL) for radiochemical analysis.

Figure 2-14: 242-F Evaporator (Cone Section)

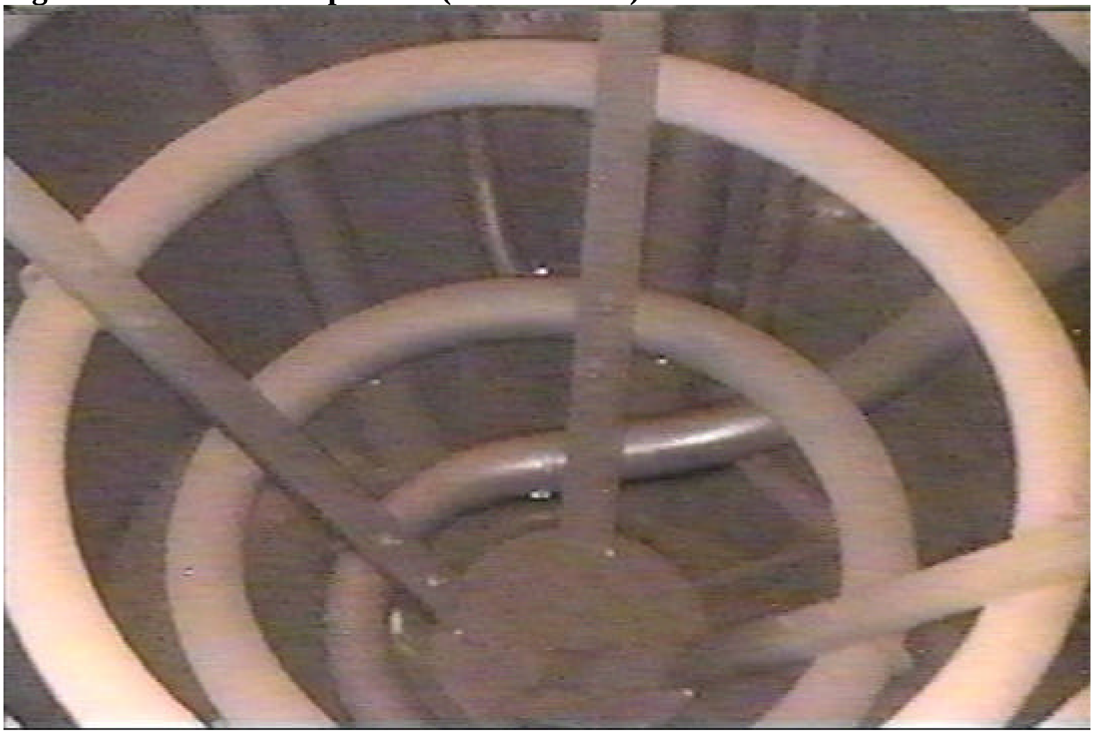
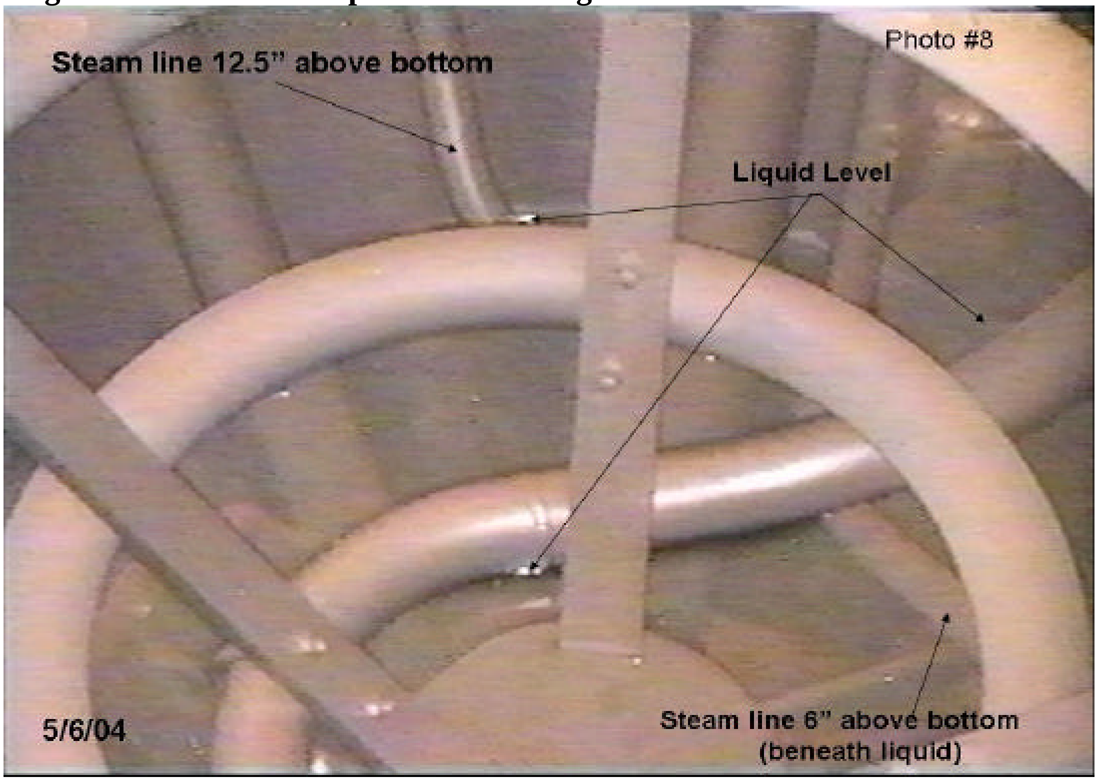


Figure 2-15: 242-F Evaporator Warming Coil Details



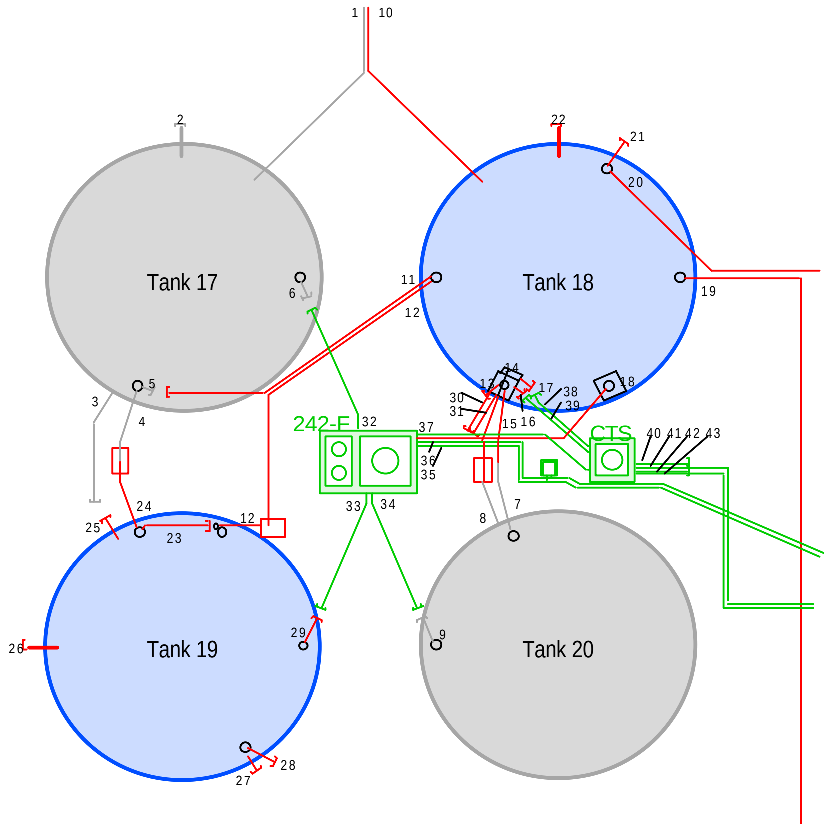
2.2 Transfer Lines in the Tanks 17-20 Area

The transfer line segments related to the Tanks 17-20 grouping (See Figure 2-16 and Appendix A) are constructed of stainless steel and are encased in jackets, with limited exceptions (cascade lines). Stainless steel is noted for its longevity due to the inherent corrosion resistance provided by the addition of chromium to the steel composition. Transfer line jackets may be constructed of carbon steel pipe or transite pipe. Some jackets contain additional service piping and/or steam tracing used to maintain the temperature of material being transferred. Neither the jacket material of construction nor the service/tracing piping impact the service life of the stainless steel core pipe. The inter- and intra- grouping transfer lines associated with Tanks 17-20 have been isolated at the vessels. The loop lines are transfer lines that form a continuous feed/return arrangement between the CTS tank and the various tank groupings: i.e., Tanks 1-4 were a group: Tanks 25-28 were a group, etc. Other transfer lines interconnected Tanks 17-20 and provided feed to and from the 242-F Evaporator. There are forty three (43) transfer lines associated with Tanks 17-20. These lines provided process capabilities for inter-tank transfers, volume reduction (through the 242-F Evaporator System), and waste receipts from the F Area canyon.

2.2.1 Transfer Line Modification and/or Remove from Service Status

Throughout the history of F-Tank Farm, some transfer lines were modified to accommodate changes in processing capabilities and needs. Occasionally lines were rerouted, and portions were cut and capped and abandoned in-place. For example, in 2002 the transfer line between Tanks 1 and 7 was modified to permit transfer of Tank 18 heel removal related waste materials to Tank 7. Based on Tank 18 project estimates (Ellzey, 2002), this modification was completed at a cost of $272,000. The per-person average dose rate was 6 mrem/hr whole body (DOE, 2002b-q). The Tank 18 modification of the Tank 1 to Tank 7 transfer line was used for cost and exposure benchmarks for this report (see Appendix D). It was chosen because it is the latest work performed on existing transfer lines in F-Tank Farm, its physical relationship to the Tanks 17-20 grouping, and because of its physical dimension, i.e., approximately 40 feet of transfer line was excavated. Initiatives related to closure preparation since 1998 have isolated additional lines, including the 242-F Evaporator System related transfer lines. Based on the historic proceduralized flushing regime—three line volume flushes following each waste sludge transfer—the transfer lines are assumed to be contaminated but free of residual sludge. Field surveys were conducted for the Tank 18 modification of the Tank 1 to Tank 7 transfer line and have supported this assumption. The use of long radius elbows in all transfer lines is an established practice since early SRS construction and serves to minimize sludge separation and hold-up in the line during transfers.

Figure 2-16: Tank 17-20 Transfer Piping Arrangement



Area Process Lines/Tank Penetrations

Closed/Isolated During Tank 17 & 20 Closure

1 - Transfer line from FDB-1 to Tank 17
2 - Tank 17 outlet line (never used)
3 - Cascade line from Tank 19 to 17
4 - Ventilation Cross Tie Line Tank 17 to 19
5 - Transfer line from Tank 17 to 18
6 - Gravity Drain Line from 242-F to Tank 17
7 - Ventilation Cross Tie Line Tank 18 to 20
8 - Cascade line from Tank 20 to 18
9 - Gravity Drain Line from 242-F to Tank 20

To Be Closed/Isolated During Tank 18 & 19 Closure

10 - Transfer line from FDB-1 to Tank 18
11 - Transfer line from Tank 17 to 18
12 - Transfer line from Tank 19 NW to NE riser
13 - Gravity Drain Line from 242-F to Tank 18
14 - Cascade line from Tank 20 to 18
15 - Ventilation Cross Tie Line Tank 18 to 20
16 - Pump line from CTS to Tank 18
17 - Vent line from CTS to Tank 18
18 - Feed line from Tank 18 to 242-F
19 - Transfer line from FDB-2 to Tank 18
20 - Transfer line from Tank 18 to 7
21 - H&V Condensate Drain Line to Tank 18

To Be Closed/Isolated During Tank 18 & 19 Closure

22 - Spare Tank 18 inlet line
23 - Transfer line from Tank 19 NE riser to 18
24 - Ventilation Cross Tie Line Tank 17 to 19
25 - Cascade line from Tank 19 to 17
26 - Spare Tank 19 inlet line
27 - Spare Tank 19 outlet line
28 - Ventilation and drain outlet from HVAC
29 - Gravity Drain Line from 242-F to Tank 19
30 - Transfer line from Tank 18 to 242-F
31 - Transfer lines (2) from Tank 18 to 242-F

To Be Closed/Isolated During 242-H/CTS Closure

32 - Gravity Drain Line from 242-F to Tank 17
33 - Gravity Drain Line from 242-F to Tank 19
34 - Gravity Drain Line from 242-F to Tank 20
35 - Old Evap. Feed line from FBD6 to 242-F
36 - Old Evap. Vent line from 242-F to FDB6
37 - Transfer line from 242-F to CTS
38 - Transfer line from Tank 18 to CTS
39 - Transfer line from Tank 18 to CTS
40 - CTS loop line from CTS to Tanks 1-4
41 - Transfer line from CTS to FDB5
42 - CTS loop line from CTS to Tanks 1-4
43 - Transfer line from FDB5 to CTS

2.2.1.1 Transfer Lines Lengths and Volumes

Table 2-2 provides a list of transfer line segments associated with Tanks 17-20. [Note: Some of the transfer segments listed in Figure 2-16 are not listed in Appendix A because they were spare tank penetrations that were never used.] Of those segments, ~20% are known to be cut, capped, and abandoned in place. For comparative purposes, the CTS related loop transfer lines (to Tanks 33-34 and Tanks 25-28) and the 242-2F gravity drain lines (to Tanks 25, 27, 44 and 47) are the only F-Tank Farm transfer lines with cleanout ports (i.e., access points into the core piping for flushing, cleaning, etc.). The remaining inter-area transfer lines in F-Tank Farm are solid runs of core pipe and secondary jackets with no cleanout ports. Appendix B provides a complete list of F-Tank Farm transfer lines, excluding those related to the Tanks 17-20 grouping, which are described in Table 2-2.

Table 2-2 Summary Table of Transfer Lines Tank 17-20 Area

Segment ID	Description	Reference	Configuration
8	18-20 Cascade Line; Isolated at W320-17-1 Valve Box near Tank 20	W717613	4" core/6" CS jacket
W318-14-2	18-20 Cascade line LDB near Tank 20	W717613	6" core
W320-17-1	Valve Box; 18-20 cascade line	W717613	6" core
7	17-19 Cascade Line; Abandoned in place; cut and capped near tank 19	W717008	4" core/6" CS jacket
176 Old	Capped/abandoned in berm between evaporator and Tank 18 SW riser	S5-2-5942, W231025	3" core/6" transite jacket
177 Old	Capped/abandoned in berm between evaporator and Tank 18 SW riser	S5-2-5942, W231025	3" core/6" transite jacket
302 Old	Capped/abandoned in berm between evaporator and Tank 18 SE riser	S5-2-5942	1-1/2 core
176A	CTS valve box to Tank 7 via FDB-6, Nozzle 6 (jumper to Nozzle 1) - Feed	S5-9-25931, S5-2-5932, S5-2-5942	3" core/4" jacket
177A	CTS valve box to Tank 7 via FDB-6 (jumper to Nozzle 2), Nozzle 5 - vent	S5-2-5931, S5-2-5932, S5-2-5942	3" core/6" jacket
176 Abandoned	Tank 7 feed from Evaporator; Bypass FDB-6; cut and capped	W701934, S5-2-5932	3" core/4" jacket
177 Abandoned	Tank 7 Return to evaporator; Bypass FDB-6; cut and capped	W701934, S5-2-5932	3" core/4" jacket
1/176A	Evaporator (nozzle 12) to CTS valve box - Feed	S5-2-5943, S5-2-5970	3" core/4" jacket
11/177A	Evaporator (Nozzles, 4, 5, 6 & 8) to CTS valve box - vent	S5-2-5943, S5-2-5970	3" core/4" jacket
2	Evaporator to Tank 18 - feed; Jacuzzi pump line	S5-2-5970, S5-2-1388, W164177	3" core/4/6" jacket
3, 4, 5, 6, 7, 8	Evaporator to Tanks 17-20 gravity drain lines	W231025	3" core/6"steam jacket/12 transite
301	CTS to Tanks 1-4 loop line	W239840, W236128	2" core/ 6" jacket
19 To 18 Transfer	19 to 18 transfer	S5-2-3524	3" core/4" jacket
17 To 18 Transfer	17 to 18 transfer	S5-2-3524	3" core/4" jacket
302	Tank 18 SW Riser to CTS	W236195	1-1/2" core/4" jacket
303	Evaporator to CTS	W236195	1-1/2" core/4" jacket
304	Tank 18 SW Riser to CTS	W236195	3" core/4" jacket
118/5016/213	Tank 7 (old Tank 1 transfer line) to Tank 18 NE riser	S5-2-5090, MTRDF00017, M-M6-F-4032	3" core/4" jacket
3 (HP-50E)	FDB1 Nozzle 28 to Tank 18	W163901, W164193	3" core/6" transite jacket
4 (HP-51E)	FDB1 Nozzle 29 to Tank 17	W163901	3" core/6" transite jacket
107/117	Tank 18 East Riser to FDB2 Nozzle 33	W235672, W236672	3" core/4" CS jacket
108	From DB3 to Tank 18 via FDB2 Nozzle 32	W235672	3" core/4" CS jacket
3265/C3	Nozzle 1 CTS Loop Line to Tanks 33/34 via FDB5 nozzle 1 jumper to nozzle	W239840, W447075, W702026	2" core/ 4, 6, 8" jacket
3266	242-F Evaporator to FDB-6	W700975, W701934, W702732, W701196, M-M6-F-3357	3” core/ 6” jacket
3275/C1	Nozzle 3 CTS Loop Line return to Tanks 33/34 via FDB5 Nozzle 2	W239840, W447075, W702026	2" core/ 4, 6, 8" jacket
3265 Abandoned	CTS Loop Line to Tanks 33/34 via FDB5	W702026	2" core/ 4, 6, 8" jacket
3275 Abandoned	CTS Loop Line return to Tanks 33/34 via FDB5	W702026	2" core/ 4, 6, 8" jacket
3277	FDB-6 to 242-F Evaporator	W700975, W701934, W702732, W701196, M-M6-F-3357	3” core/ 6” jacket

2.2.1.2 Tanks 17-20 Related Transfer Line Lengths

The abandoned lines represent ~20% (~2300') of the total length (~10400') of transfer lines associated with the Tanks 17-20 group (Table 2-3). This 20% is dominated by line segment 301, the CTS loop line to Tanks 1-4. This buried line is isolated (cut and capped) within 20 feet of the CTS pit. Several of the cut and capped lines are buried in the high-radiation berm between the 242-F Evaporator and Tank 18 Southeast and Southwest risers. Other cut and capped lines exist as short segments near diversion boxes where lines have been rerouted for nozzle placements.

Table 2-3 Summary Table of Transfer Line Lengths

Line Segment	Reference	Approximate Length (feet)
8	W717613	55
W318-14-2	W717613	55
W320-17-1	W717613	55
7	W717008	55
176 Old	S5-2-5942, W231025	20
177 Old	S5-2-5942, W231025	20
302 Old	S5-2-4952	20
176A	S5-2-5931, S5-2-5932, S5-2-5942	500
177A	S5-2-5931, S5-2-5932, S5-2-5942	500
176 Abandoned	W701934, S5-2-5932	40
177 Abandoned	W701934, S5-2-5932	40
1/176A	S5-2-5943, S5-2-5970	50
11/177A	S5-2-5943, S5-2-5970	50
2	S5-2-5970, S5-2-1388, W164177	80
3, 4, 5, 6, 7, 8	W231025	6' ea. (est'd)
301	W239840, W236128	1942
19 to 18 transfer	S5-2-3524	144
17 to 18 transfer	S5-2-3524	106
302	W236195	70
303	W236195	70
304	W236195	70
118/5016/213	S5-2-5090, M-TRD-F-00017, M-M6-F-4032	670
3 (HP-50E)	W163901, W164193	430
4 (HP-51E)	W163901	480
107/117	W235672, W236672	648
108	W235672	450
3265/C3	W239840, W447075, W702026	1910
3266	W700975, W701934, W702732, W701196, M-M6-F-3357	324
3275/C1	W239840, W447075, W702026	1910
3265 Abandoned	W702026	22
3275 Abandoned	W702026	22
3277	W700975, W701934, W702732, W701196, M-M6-F-3357	324
	Total	~10400

2.2.1.3 Tanks 17-20 Transfer Line Volumes

The transfer line piping varies in diameter from 2 inches to 4 inches (core pipe only) over specific line segments. An algorithm was created in a spreadsheet to estimate the volume of each transfer line segment. A summary of line segment volumes is presented in Table 2-4. The sum of the segment volume, ~370 $feet^3$ represents the volume of stabilization material that would be required if 100% fill efficiencies could be achieved during transfer line stabilization efforts.

Table 2-4: Summary Table of Transfer Line Volumes

Segment	Volume ($feet^3$)
19 to 18 transfer	7
17 to 18 transfer	5
302	1
303	5
304	3
118/5016/213	33
3 (HP-50E)	21
4 (HP-51E)	24
107/117	32
108	22
3265/C3	42
3275/C1	42
3265 Abandoned	1
3266	2
3275 Abandoned	1
3277	2
Total	~350

Segment	Volume ($feet^3$)
8	5
W318-14-2	19
W320-17-1	19
7	5
176 Old	1
177 Old	1
302 Old	1
176A	15
177A	15
176 Abandoned	2
177 Abandoned	2
1/176A	2
11/177A	2
2	4
3, 4, 5, 6, 7, 8 GDLs	2 total
301	42

3.0 CHARACTERIZATION OF RESIDUALS AFTER CLEANING OF THE 242-F EVAPORATOR SYSTEM AND TRANSFER LINES

3.1 Summary of Final Volume of Residual Solids in the 242-F Evaporator System

The estimate of final volume of 242-F Evaporator System solids is a compilation of the estimates from the 242-F system components—tanks, vessels and sumps. Table 3-1 provides a breakdown of the compilation. Debris volumes, e.g., dropped hard hats, have not been included.

Table 3-1 Residual Solids Volume (Gallons)

242-F Evaporator System Components	Solids Related to Waste processing	Solids from Waste Processing Support (zeolite, etc.)	Total, all solids
242-F Evaporator	0.3	None detected	0.3
242-F Evaporator Cell Floor and Sump	None detected	None detected	0
242-F Receiver Cell Floor and Sump	None detected	None Detected	0
242-3F CTS Vessel (Waltz, 2005)	90	None Detected	90
242-3F CTS Pit Floor and Sump	None detected	None Detected	0
242-F North Overheads Tank (SW1.9, 1997)	None detected	14	14
242-F South Overheads Tank (SW1.9, 1997)	None detected	98	98
242-F Condenser	None detected	None detected	0
242-F System Total	90.3	112	202.3

3.1.1 Estimating the Volume of Residual Liquid

The volume of liquid in the 242-F Evaporator System was estimated using video inspection following heel removal. The volume of interstitial supernate in freshly slurried sludge has been estimated to be 70 volume percent for settled sludge (Fowler, 1982) and 85 volume percent for freshly slurried sludge (Landon and Thompson, 1980). For calculation purposes associated with the 242-F Evaporator System, the volume of interstitial liquid is conservatively estimated to be 85 volume percent, the higher of the two numbers. Using criteria applied to Tank 19 (d'Entremont and Thomas, 2002), the 85 volume percent is also applied to the zeolite residuals: therefore, the volume of liquid in the solids is estimated as:

$$Xgal_{solids} \times 0.85 = Ygal_{interstitial}$$

Since the interstitial liquid is assumed to be flush and rainwater, a specific gravity of 1.0 has been assumed for calculations.

In addition to the interstitial liquid in the non-waste sludge, free liquid also exists in some vessels. The total estimated volume of liquid in the 242-F Evaporator System is ~150 gallons of interstitial liquid plus 69 gallons of free liquid, or ~220 gallons. Table 3-2 lists the liquid volume estimate for each of the 242-F Evaporator System's vessels. Given the volumes listed in Table 3-2, the mass of interstitial liquids for each of the vessels is: Overheads vessels, 360 Kg; CTS vessel, 193 Kg; and evaporator, 4 Kg.

Table 3-2 Table of Estimated Residual Liquids (Gallons)

	Free liquid	Interstitial liquid	Total Liquid
242-F Receiver Cell Sump	10	0	10
242-F North Overheads Tank	2	12	14
242-F South Overheads Tank	2	83	85
242-F Condenser	0	0	0
242-3F CTS Vessel[1]	5	51	56
242-3F CTS pit sump	10	0	10
242-F Evaporator	30	<1	31
242-F Evaporator Cell Sump	10	0	10
242-F System Total	69	~150	220

[1] Estimated based on heel removal equipment run times. No post heel removal inspection performed due to As Low As Reasonably Achievable (ALARA) personnel protection considerations.

3.2 Summary of Radionuclide Inventories in the 242-F System

Table 3-3 lists the radionuclide inventories for the 242-F Evaporator System equipment components associated with the Tanks 17-20 grouping (242-F Evaporator, CTS and Overheads). Table 3-3 reflects both sample results and historic records as reported by Nguyen (2005) for the additional ancillary equipment associated with the Tanks 17-20 grouping.

Analyses of the remaining residual waste in the 242-F Evaporator System indicate that there are two types of residual process waste remaining—solids (waste insoluble solids and non-waste solids, e.g., zeolite) and liquid (aqueous salt solution). Based on dose rates and video inspections, there is no indication of waste insoluble solids in the 242-F Evaporator System's pit and cells; residual waste insoluble solids is confined to the evaporator vessel and the CTS tank (Hay, 2004). Radiochemistry analysis (Hay, 2004 and Swingle, 2004b) performed at the Savannah River National Laboratory (SRNL), indicates that most of the radionuclides remaining in the evaporator vessel and concentrate transfer system (CTS) pump tank are the result of processing F-Canyon Plutonium Recovery and Extraction (PUREX) low heat waste streams. The overheads tanks contain zeolite, a resin used to remove Cs-137 from the overheads stream.

Table 3-3: Summary Table of 242-F Evaporator System Contamination (Ci)

	Overheads	CTS tank	Evaporator Vessel
H-3	1.44E-01	1.08E-01	1.51E-03
C-14	5.37E-04	1.48E-01	2.32E-02
Co-60	2.02E-04	5.58E-02	1.25E-01
Ni-59	3.16E-02	8.72E+00	1.36E+00
Ni-63	2.86E+00	7.91E+02	1.24E+02
Se-79	1.33E-04	1.18E-06	7.78E-07
Sr-90	1.30E-01	3.58E+01	5.60E+00
Y-90	1.30E-01	3.58E+01	5.60E+00
Nb-94	1.39E-09	3.83E-07	5.98E-08
Tc-99	8.98E-04	7.30E-02	1.29E-01
Ru-106	1.36E-06	3.77E-04	5.88E-05
Rh-106	1.36E-06	3.77E-04	5.88E-05
Sb-125	2.86E-03	7.89E-01	1.23E-01
Sn-126	2.56E-04	7.06E-02	1.10E-02
I-129	2.15E-04	5.94E-02	9.28E-03
Cs-134	2.45E-03	6.76E-01	1.06E-01
Cs-135	3.03E-05	8.36E-03	1.31E-03
Cs-137	2.41E+00	4.55E+02	9.59E+01
Ba-137m	2.28E+00	4.30E+02	9.08E+01
Ce-144	3.43E-11	9.46E-09	1.48E-09
Pr-144	1.71E-08	4.73E-06	7.39E-07
Pm-147	8.48E-04	2.34E-01	3.66E-02
Eu-154	4.66E-04	1.29E-01	2.01E-02
U-232	1.74E-05	4.81E-03	7.52E-04
U-233	1.02E-02	2.14E-03	1.13E-03
U-234	6.59E-03	1.39E-03	7.15E-04
U-235	2.27E-06	3.49E-06	8.20E-06
U-236	6.79E-05	1.44E-05	1.38E-05
U-238	1.94E-06	2.62E-04	7.57E-04
Np-237	7.42E-04	3.16E-04	3.66E-04
Pu-238	1.81E-02	6.95E-01	5.40E-01
Pu-239	6.55E-02	9.80E-01	1.41E+00
Pu-240	2.39E-01	2.57E-01	3.12E-01
Pu-241	3.17E-02	3.56E+00	4.45E+00
Pu-242	4.03E-03	8.72E-04	4.52E-04
Am-241	2.95E-03	6.95E-01	4.15E-01
Am-242m	4.58E-04	1.27E-01	1.98E-02
Cm-244	3.18E-08	8.78E-06	1.37E-06
Cm-245	2.24E-14	6.18E-12	9.65E-13
Te-125m	6.98E-04	1.93E-01	3.01E-02
Sb-126	3.58E-05	9.88E-03	1.54E-03
Sb-126m	2.56E-04	7.06E-02	1.10E-02
Sm-151	4.25E-03	1.17E+00	1.83E-01
Eu-152	1.84E-05	5.07E-03	7.92E-04
Eu-155	2.47E-04	6.83E-02	1.07E-02
Ra-226	1.48E-08	3.13E-09	1.61E-09
Ac-227	5.18E-10	7.96E-10	1.87E-09
Th-229	2.90E-05	6.10E-06	3.21E-06
Th-230	1.82E-06	3.83E-07	1.97E-07
Pa-231	1.44E-09	2.21E-09	5.20E-09
Pu-244	3.82E-11	1.05E-08	1.65E-09
Am-243	5.71E-10	1.58E-07	2.46E-08
Cm-242	2.96E-24	8.18E-22	1.28E-22
Cm-243	8.83E-09	2.44E-06	3.81E-07
Cm-247	2.01E-22	5.56E-20	8.69E-21
Cm-248	4.65E-23	1.28E-20	2.01E-21
Bk-249	1.75E-32	4.83E-30	7.55E-31
Cf-249	1.29E-24	3.57E-22	5.58E-23
Al-26	7.29E-06	2.01E-03	3.15E-04

3.3 Summary of Final Volume of Residual Solids in the Transfer Lines

Table 3-4 lists the estimated radionuclide inventories assigned to each of the transfer line segments associated with the Tanks 17-20 grouping (Caldwell, 2005). The estimated radionuclide inventories assigned in Table 3-4 are analytically derived. The results were compared to results from standard characterization techniques using field surveys. Actual field survey data was used for isotopic concentrations that were greater than those calculated analytically. Waste in contact with piping systems adheres to the pipe in three ways:

1. Diffusion into the metal – Diffusion is the technique for carburizing and nitriding of metals and therefore is a known industrial transport phenomenon.

2. Residue by diffusion into oxide film – Stainless and carbon steels form an oxide film, which provides corrosion protection. A conservative assumption equates the isotopic concentration of the layer to that of the sludge.

3. Residue of particles left behind after a flush – Water is used to flush transfer piping as the conclusion to a waste transfer through those lines. The purpose of this flush is to clear the lines of remaining sludge residue in the transfer line piping.

Further characterization of the transfer line inventories can be achieved in several ways, including by sampling, as was done for the radionuclide inventories for the 242-F Evaporator System components.

Table 3-4: Summary Table of Transfer Line Contamination (Ci)

Line No.(1)	H-3	C-14	Al-26	Co-60	Ni-59	Ni-63	Se-79	Sr-90	Y-90	Nb-94	Tc-99	Rh-106	Ru-106	Te-125m	Sb-125	Sb-126
1/176A	2.53E-02	7.54E-08	1.09E-05	4.27E-02	8.27E-05	8.26E-03	5.92E-05	8.23E+00	8.23E+00	4.44E-08	1.16E-03	1.10E-03	1.10E-03	1.03E-02	4.20E-02	1.54E-05
2	4.04E-02	1.21E-07	1.75E-05	6.84E-02	1.32E-04	1.32E-02	9.47E-05	1.32E+01	1.32E+01	7.11E-08	1.85E-03	1.75E-03	1.75E-03	1.64E-02	6.72E-02	2.47E-05
3	2.17E-01	6.48E-07	9.39E-05	3.67E-01	7.11E-04	7.10E-02	5.09E-04	7.08E+01	7.08E+01	3.82E-07	9.97E-03	9.43E-03	9.43E-03	8.82E-02	3.61E-01	1.33E-04
4	2.43E-01	7.24E-07	1.05E-04	4.10E-01	7.94E-04	7.93E-02	5.68E-04	7.90E+01	7.90E+01	4.26E-07	1.11E-02	1.05E-02	1.05E-02	9.85E-02	4.03E-01	1.48E-04
7	3.96E-02	1.43E-07	2.06E-05	8.07E-02	1.56E-04	1.56E-02	1.12E-04	1.56E+01	1.56E+01	8.39E-08	2.19E-03	2.07E-03	2.07E-03	1.94E-02	7.94E-02	2.91E-05
8	3.96E-02	1.43E-07	2.06E-05	8.07E-02	1.56E-04	1.56E-02	1.12E-04	1.56E+01	1.56E+01	8.39E-08	2.19E-03	2.07E-03	2.07E-03	1.94E-02	7.94E-02	2.91E-05
11/177A	2.53E-02	7.54E-08	1.09E-05	4.27E-02	8.27E-05	8.26E-03	5.92E-05	8.23E+00	8.23E+00	4.44E-08	1.16E-03	1.10E-03	1.10E-03	1.03E-02	4.20E-02	1.54E-05
107/117	3.25E-01	9.70E-07	1.41E-04	5.49E-01	1.06E-03	1.06E-01	7.61E-04	1.06E+02	1.06E+02	5.71E-07	1.49E-02	1.41E-02	1.41E-02	1.32E-01	5.40E-01	1.98E-04
108 (Tk18)	2.27E-01	6.79E-07	9.83E-05	3.85E-01	7.44E-04	7.43E-02	5.33E-04	7.41E+01	7.41E+01	4.00E-07	1.04E-02	9.86E-03	9.86E-03	9.23E-02	3.78E-01	1.39E-04
118 of 118/5016/213	1.50E-01	4.46E-07	6.47E-05	2.53E-01	4.89E-04	4.89E-02	3.51E-04	4.87E+01	4.87E+01	2.63E-07	6.86E-03	6.49E-03	6.49E-03	6.07E-02	2.49E-01	9.13E-05
176 Old	1.01E-02	3.02E-08	4.37E-06	1.71E-02	3.31E-05	3.30E-03	2.37E-05	3.29E+00	3.29E+00	1.78E-08	4.64E-04	4.38E-04	4.38E-04	4.10E-03	1.68E-02	6.17E-06
176A	2.53E-01	7.54E-07	1.09E-04	4.27E-01	8.27E-04	8.26E-02	5.92E-04	8.23E+01	8.23E+01	4.44E-07	1.16E-02	1.10E-02	1.10E-02	1.03E-01	4.20E-01	1.54E-04
176 Abandoned	2.02E-02	6.03E-08	8.74E-06	3.42E-02	6.61E-05	6.61E-03	4.74E-05	6.58E+00	6.58E+00	3.55E-08	9.27E-04	8.77E-04	8.77E-04	8.21E-03	3.36E-02	1.23E-05
177 Old	1.01E-02	3.02E-08	4.37E-06	1.71E-02	3.31E-05	3.30E-03	2.37E-05	3.29E+00	3.29E+00	1.78E-08	4.64E-04	4.38E-04	4.38E-04	4.10E-03	1.68E-02	6.17E-06
177A	2.53E-01	7.54E-07	1.09E-04	4.27E-01	8.27E-04	8.26E-02	5.92E-04	8.23E+01	8.23E+01	4.44E-07	1.16E-02	1.10E-02	1.10E-02	1.03E-01	4.20E-01	1.54E-04
177 Abandoned	1.01E-02	3.02E-08	4.37E-06	1.71E-02	3.31E-05	3.30E-03	2.37E-05	3.29E+00	3.29E+00	1.78E-08	4.64E-04	4.38E-04	4.38E-04	4.10E-03	1.68E-02	6.17E-06
213 of 118/5016/213	1.90E-01	5.67E-07	8.21E-05	3.21E-01	6.22E-04	6.21E-02	4.45E-04	6.19E+01	6.19E+01	3.34E-07	8.72E-03	8.24E-03	8.24E-03	7.72E-02	3.16E-01	1.16E-04
301	6.02E-01	1.34E-06	1.94E-04	7.57E-01	1.47E-03	1.46E-01	1.05E-03	1.46E+02	1.46E+02	7.87E-07	2.05E-02	1.94E-02	1.94E-02	1.82E-01	7.44E-01	2.73E-04
302	2.02E-02	7.25E-08	1.05E-05	4.11E-02	7.95E-05	7.94E-03	5.70E-05	7.92E+00	7.92E+00	4.27E-08	1.12E-03	1.05E-03	1.05E-03	9.87E-03	4.04E-02	1.48E-05
302 Old	5.76E-03	2.07E-08	3.00E-06	1.17E-02	2.27E-05	2.27E-03	1.63E-05	2.26E+00	2.26E+00	1.22E-08	3.19E-04	3.01E-04	3.01E-04	2.82E-03	1.16E-02	4.24E-06
303	2.02E-02	7.25E-08	1.05E-05	4.11E-02	7.95E-05	7.94E-03	5.70E-05	7.92E+00	7.92E+00	4.27E-08	1.12E-03	1.05E-03	1.05E-03	9.87E-03	4.04E-02	1.48E-05
304	3.54E-02	1.06E-07	1.53E-05	5.98E-02	1.16E-04	1.16E-02	8.29E-05	1.15E+01	1.15E+01	6.22E-08	1.62E-03	1.53E-03	1.53E-03	1.44E-02	5.88E-02	2.16E-05
3265	5.92E-01	1.31E-06	1.90E-04	7.45E-01	1.44E-03	1.44E-01	1.03E-03	1.43E+02	1.43E+02	7.74E-07	2.02E-02	1.91E-02	1.91E-02	1.79E-01	7.32E-01	2.69E-04
3265-B	6.82E-03	1.51E-08	2.19E-06	8.58E-03	1.66E-05	1.66E-03	1.19E-05	1.65E+00	1.65E+00	8.91E-09	2.33E-04	2.20E-04	2.20E-04	2.06E-03	8.43E-03	3.09E-06
3266	1.111E-02	3.317E-08	4.806E-06	1.880E-02	3.637E-05	3.634E-03	2.605E-05	3.621E+00	3.621E+00	1.954E-08	5.100E-04	4.822E-04	4.822E-04	4.514E-03	1.849E-02	6.782E-06
3275	5.92E-01	1.31E-06	1.90E-04	7.45E-01	1.44E-03	1.44E-01	1.03E-03	1.43E+02	1.43E+02	7.74E-07	2.02E-02	1.91E-02	1.91E-02	1.79E-01	7.32E-01	2.69E-04
3275-B	6.82E-03	1.51E-08	2.19E-06	8.58E-03	1.66E-05	1.66E-03	1.19E-05	1.65E+00	1.65E+00	8.91E-09	2.33E-04	2.20E-04	2.20E-04	2.06E-03	8.43E-03	3.09E-06
3277	1.111E-02	3.317E-08	4.806E-06	1.880E-02	3.637E-05	3.634E-03	2.605E-05	3.621E+00	3.621E+00	1.954E-08	5.100E-04	4.822E-04	4.822E-04	4.514E-03	1.849E-02	6.782E-06
5016 of 118/5016/213+B18	2.73E-02	8.14E-08	1.18E-05	4.61E-02	8.93E-05	8.92E-03	6.40E-05	8.89E+00	8.89E+00	4.80E-08	1.25E-03	1.18E-03	1.18E-03	1.11E-02	4.54E-02	1.67E-05
W320-17-1 9852	5.76E-03	2.07E-08	3.00E-06	1.17E-02	2.27E-05	2.27E-03	1.63E-05	2.26E+00	2.26E+00	1.22E-08	3.19E-04	3.01E-04	3.01E-04	2.82E-03	1.16E-02	4.24E-06
W318-14-2	5.76E-03	2.07E-08	3.00E-06	1.17E-02	2.27E-05	2.27E-03	1.63E-05	2.26E+00	2.26E+00	1.22E-08	3.19E-04	3.01E-04	3.01E-04	2.82E-03	1.16E-02	4.24E-06
3, 4, 5, 6, 7, 8 GDLs	1.82E-02	5.43E-08	7.86E-06	3.08E-02	5.95E-05	5.95E-03	4.26E-05	5.93E+00	5.93E+00	3.20E-08	8.35E-04	7.89E-04	7.89E-04	7.39E-03	3.03E-02	1.11E-05
19 to 18 transfer	7.28E-02	2.17E-07	3.15E-05	1.23E-01	2.38E-04	2.38E-02	1.71E-04	2.37E+01	2.37E+01	1.28E-07	3.34E-03	3.16E-03	3.16E-03	2.96E-02	1.21E-01	4.44E-05
17 to 18 transfer	5.36E-02	1.60E-07	2.32E-05	9.06E-02	1.75E-04	1.75E-02	1.26E-04	1.75E+01	1.75E+01	9.41E-08	2.46E-03	2.32E-03	2.32E-03	2.18E-02	8.91E-02	3.27E-05
Total	2.66E+02	1.33E-05	1.92E-03	7.52E+00	1.46E-02	1.45E+00	1.04E-02	1.45E+03	1.45E+03	7.82E-06	2.04E-01	1.93E-01	1.93E-01	1.81E+00	7.40E+00	2.71E-03

Table 3-4: Summary Table of Transfer Line Contamination (Ci) , cont'd

Line No.(1)	Sb-126m	Sn-126	I-129	Cs-134	Cs-135	Cs-137	Ba-137m	Ce-144	Pr-144	Pm-147	Sm-151	Eu-152	Eu-154	Eu-155	Ra-226
1/176A	1.10E-04	1.10E-04	1.10E-06	3.03E-02	6.85E-07	1.03E+01	9.74E+00	1.54E-04	1.54E-04	7.21E-01	2.15E-01	1.67E-03	9.02E-02	8.23E-02	8.95E-08
2	1.76E-04	1.76E-04	1.76E-06	4.84E-02	1.10E-06	1.65E+01	1.56E+01	2.47E-04	2.47E-04	1.15E+00	3.43E-01	2.68E-03	1.44E-01	1.32E-01	1.43E-07
3	9.47E-04	9.47E-04	9.47E-06	2.60E-01	5.89E-06	8.86E+01	8.38E+01	1.33E-03	1.33E-03	6.20E+00	1.85E+00	1.44E-02	7.76E-01	7.08E-01	7.69E-07
4	1.06E-03	1.06E-03	1.06E-05	2.90E-01	6.58E-06	9.89E+01	9.35E+01	1.48E-03	1.48E-03	6.92E+00	2.06E+00	1.61E-02	8.66E-01	7.90E-01	8.59E-07
7	2.08E-04	2.08E-04	2.08E-06	5.72E-02	1.30E-06	1.95E+01	1.84E+01	2.92E-04	2.92E-04	1.36E+00	4.05E-01	3.16E-03	1.71E-01	1.56E-01	1.69E-07
8	2.08E-04	2.08E-04	2.08E-06	5.72E-02	1.30E-06	1.95E+01	1.84E+01	2.92E-04	2.92E-04	1.36E+00	4.05E-01	3.16E-03	1.71E-01	1.56E-01	1.69E-07
11/177A	1.10E-04	1.10E-04	1.10E-06	3.03E-02	6.85E-07	1.03E+01	9.74E+00	1.54E-04	1.54E-04	7.21E-01	2.15E-01	1.67E-03	9.02E-02	8.23E-02	8.95E-08
107/117	1.42E-03	1.42E-03	1.42E-05	3.89E-01	8.81E-06	1.32E+02	1.25E+02	1.98E-03	1.98E-03	9.27E+00	2.76E+00	2.15E-02	1.16E+00	1.06E+00	1.15E-06
108 (Tk18)	9.91E-04	9.91E-04	9.91E-06	2.72E-01	6.17E-06	9.27E+01	8.77E+01	1.39E-03	1.39E-03	6.49E+00	1.93E+00	1.51E-02	8.12E-01	7.41E-01	8.05E-07
118 of 118/5016/213	6.52E-04	6.52E-04	6.52E-06	1.79E-01	4.06E-06	6.10E+01	5.77E+01	9.13E-04	9.13E-04	4.27E+00	1.27E+00	9.90E-03	5.34E-01	4.87E-01	5.30E-07
176 Old	4.40E-05	4.40E-05	4.41E-07	1.21E-02	2.74E-07	4.12E+00	3.90E+00	6.17E-05	6.17E-05	2.88E-01	8.58E-02	6.69E-04	3.61E-02	3.29E-02	3.58E-08
176A	1.10E-03	1.10E-03	1.10E-05	3.03E-01	6.85E-06	1.03E+02	9.74E+01	1.54E-03	1.54E-03	7.21E+00	2.15E+00	1.67E-02	9.02E-01	8.23E-01	8.95E-07
176 Abandoned	8.81E-05	8.81E-05	8.81E-07	2.42E-02	5.48E-07	8.24E+00	7.79E+00	1.23E-04	1.23E-04	5.77E-01	1.72E-01	1.34E-03	7.22E-02	6.58E-02	7.16E-08
177 Old	4.40E-05	4.40E-05	4.41E-07	1.21E-02	2.74E-07	4.12E+00	3.90E+00	6.17E-05	6.17E-05	2.88E-01	8.58E-02	6.69E-04	3.61E-02	3.29E-02	3.58E-08
177A	1.10E-03	1.10E-03	1.10E-05	3.03E-01	6.85E-06	1.03E+02	9.74E+01	1.54E-03	1.54E-03	7.21E+00	2.15E+00	1.67E-02	9.02E-01	8.23E-01	8.95E-07
177 Abandoned	4.40E-05	4.40E-05	4.41E-07	1.21E-02	2.74E-07	4.12E+00	3.90E+00	6.17E-05	6.17E-05	2.88E-01	8.58E-02	6.69E-04	3.61E-02	3.29E-02	3.58E-08
213 of 118/5016/213	8.28E-04	8.28E-04	8.28E-06	2.28E-01	5.15E-06	7.74E+01	7.33E+01	1.16E-03	1.16E-03	5.42E+00	1.61E+00	1.26E-02	6.79E-01	6.19E-01	6.73E-07
301	1.95E-03	1.95E-03	1.95E-05	5.36E-01	1.21E-05	1.82E+02	1.73E+02	2.73E-03	2.73E-03	1.28E+01	3.80E+00	2.96E-02	1.60E+00	1.46E+00	1.59E-06
302	1.06E-04	1.06E-04	1.06E-06	2.91E-02	6.59E-07	9.90E+00	9.37E+00	1.48E-04	1.48E-04	6.93E-01	2.06E-01	1.61E-03	8.68E-02	7.91E-02	8.60E-08
302 Old	3.03E-05	3.03E-05	3.03E-07	8.31E-03	1.88E-07	2.83E+00	2.68E+00	4.24E-05	4.24E-05	1.98E-01	5.89E-02	4.60E-04	2.48E-02	2.26E-02	2.46E-08
303	1.06E-04	1.06E-04	1.06E-06	2.91E-02	6.59E-07	9.90E+00	9.37E+00	1.48E-04	1.48E-04	6.93E-01	2.06E-01	1.61E-03	8.68E-02	7.91E-02	8.60E-08
304	1.54E-04	1.54E-04	1.54E-06	4.24E-02	9.59E-07	1.44E+01	1.36E+01	2.16E-04	2.16E-04	1.01E+00	3.00E-01	2.34E-03	1.26E-01	1.15E-01	1.25E-07
3265	1.92E-03	1.92E-03	1.92E-05	5.27E-01	1.19E-05	1.79E+02	1.70E+02	2.69E-03	2.69E-03	1.26E+01	3.74E+00	2.91E-02	1.57E+00	1.43E+00	1.56E-06
3265-B	2.21E-05	2.21E-05	2.21E-07	6.07E-03	1.38E-07	2.07E+00	1.96E+00	3.10E-05	3.10E-05	1.45E-01	4.31E-02	3.36E-04	1.81E-02	1.65E-02	1.80E-08
3266	4.844E-05	4.844E-05	4.845E-07	1.331E-02	3.015E-07	4.531E+00	4.286E+00	6.788E-05	6.788E-05	3.171E-01	9.437E-02	7.359E-04	3.970E-02	3.621E-02	3.936E-08
3275	1.92E-03	1.92E-03	1.92E-05	5.27E-01	1.19E-05	1.79E+02	1.70E+02	2.69E-03	2.69E-03	1.26E+01	3.74E+00	2.91E-02	1.57E+00	1.43E+00	1.56E-06
3275-B	2.21E-05	2.21E-05	2.21E-07	6.07E-03	1.38E-07	2.07E+00	1.96E+00	3.10E-05	3.10E-05	1.45E-01	4.31E-02	3.36E-04	1.81E-02	1.65E-02	1.80E-08
3277	4.844E-05	4.844E-05	4.845E-07	1.331E-02	3.015E-07	4.531E+00	4.286E+00	6.788E-05	6.788E-05	3.171E-01	9.437E-02	7.359E-04	3.970E-02	3.621E-02	3.936E-08
5016 of 118/5016/213+B18	1.19E-04	1.19E-04	1.19E-06	3.27E-02	7.40E-07	1.11E+01	1.05E+01	1.67E-04	1.67E-04	7.79E-01	2.32E-01	1.81E-03	9.75E-02	8.89E-02	9.66E-08
W320-17-1 9852	3.03E-05	3.03E-05	3.03E-07	8.31E-03	1.88E-07	2.83E+00	2.68E+00	4.24E-05	4.24E-05	1.98E-01	5.90E-02	4.60E-04	2.48E-02	2.26E-02	2.46E-08
W318-14-2	3.03E-05	3.03E-05	3.03E-07	8.31E-03	1.88E-07	2.83E+00	2.68E+00	4.24E-05	4.24E-05	1.98E-01	5.90E-02	4.60E-04	2.48E-02	2.26E-02	2.46E-08
3, 4, 5, 6, 7, 8 GDLs	7.93E-05	7.93E-05	7.93E-07	2.18E-02	4.93E-07	7.41E+00	7.01E+00	1.11E-04	1.11E-04	5.19E-01	1.54E-01	1.20E-03	6.50E-02	5.93E-02	6.44E-08
19 to 18 transfer	3.17E-04	3.17E-04	3.17E-06	8.71E-02	1.97E-06	2.97E+01	2.81E+01	4.44E-04	4.44E-04	2.08E+00	6.18E-01	4.82E-03	2.60E-01	2.37E-01	2.58E-07
17 to 18 transfer	2.33E-04	2.33E-04	2.33E-06	6.41E-02	1.45E-06	2.18E+01	2.07E+01	3.27E-04	3.27E-04	1.53E+00	4.55E-01	3.55E-03	1.91E-01	1.74E-01	1.90E-07
Total	1.94E-02	1.94E-02	1.94E-04	5.33E+00	1.21E-04	1.81E+03	1.72E+03	2.72E-02	2.72E-02	1.27E+02	3.78E+01	2.95E-01	1.59E+01	1.45E+01	1.58E-05

Table 3-4: Summary Table of Transfer Line Contamination (Ci) , cont'd

Line No.(1)	Ra-228	Ac-227	Th-229	Th-230	Th-232	Pa-231	U-232	U-233	U-234	U-235	U-236	U-238	Np-237	Pu-238	Pu-239	Pu-240
1/176A	0.00E+00	2.70E-09	7.71E-03	1.14E-07	0.00E+00	2.71E-09	7.60E-07	1.24E-02	1.29E-06	1.42E-08	3.27E-07	5.17E-07	2.31E-06	3.22E-01	2.87E-03	2.01E-03
2	0.00E+00	4.32E-09	1.23E-02	1.83E-07	0.00E+00	4.33E-09	1.22E-06	1.98E-02	2.06E-06	2.27E-08	5.22E-07	8.27E-07	3.69E-06	5.15E-01	4.59E-03	3.21E-03
3	0.00E+00	2.32E-08	6.63E-02	9.84E-07	0.00E+00	2.33E-08	6.54E-06	1.06E-01	1.11E-05	1.22E-07	2.81E-06	4.44E-06	1.99E-05	2.77E+00	2.47E-02	1.73E-02
4	0.00E+00	2.59E-08	7.40E-02	1.10E-06	0.00E+00	2.60E-08	7.30E-06	1.19E-01	1.23E-05	1.36E-07	3.13E-06	4.96E-06	2.22E-05	3.09E+00	2.75E-02	1.93E-02
7	0.00E+00	5.10E-09	1.46E-02	2.16E-07	0.00E+00	5.11E-09	1.44E-06	2.33E-02	2.43E-06	2.68E-08	6.17E-07	9.77E-07	4.36E-06	6.08E-01	5.42E-03	3.79E-03
8	0.00E+00	5.10E-09	1.46E-02	2.16E-07	0.00E+00	5.11E-09	1.44E-06	2.33E-02	2.43E-06	2.68E-08	6.17E-07	9.77E-07	4.36E-06	6.08E-01	5.42E-03	3.79E-03
11/177A	0.00E+00	2.70E-09	7.71E-03	1.14E-07	0.00E+00	2.71E-09	7.60E-07	1.24E-02	1.29E-06	1.42E-08	3.27E-07	5.17E-07	2.31E-06	3.22E-01	2.87E-03	2.01E-03
107/117	0.00E+00	3.47E-08	9.92E-02	1.47E-06	0.00E+00	3.48E-08	9.77E-06	1.59E-01	1.65E-05	1.83E-07	4.20E-06	6.65E-06	2.97E-05	4.14E+00	3.69E-02	2.58E-02
108 (Tk18)	0.00E+00	2.43E-08	6.94E-02	1.03E-06	0.00E+00	2.43E-08	6.84E-06	1.11E-01	1.16E-05	1.28E-07	2.94E-06	4.65E-06	2.08E-05	2.90E+00	2.58E-02	1.81E-02
118 of 118/5016/213	0.00E+00	1.60E-08	4.56E-02	6.77E-07	0.00E+00	1.60E-08	4.50E-06	7.31E-02	7.61E-06	8.41E-08	1.93E-06	3.06E-06	1.37E-05	1.91E+00	1.70E-02	1.19E-02
176 Old	0.00E+00	1.08E-09	3.08E-03	4.58E-08	0.00E+00	1.08E-09	3.04E-07	4.94E-03	5.14E-07	5.68E-09	1.31E-07	2.07E-07	9.23E-07	1.29E-01	1.15E-03	8.02E-04
176A	0.00E+00	2.70E-08	7.71E-02	1.14E-06	0.00E+00	2.71E-08	7.60E-06	1.24E-01	1.29E-05	1.42E-07	3.27E-06	5.17E-06	2.31E-05	3.22E+00	2.87E-02	2.01E-02
176 Abandoned	0.00E+00	2.16E-09	6.17E-03	9.15E-08	0.00E+00	2.16E-09	6.08E-07	9.88E-03	1.03E-06	1.14E-08	2.61E-07	4.13E-07	1.85E-06	2.58E-01	2.29E-03	1.61E-03
177 Old	0.00E+00	1.08E-09	3.08E-03	4.58E-08	0.00E+00	1.08E-09	3.04E-07	4.94E-03	5.14E-07	5.68E-09	1.31E-07	2.07E-07	9.23E-07	1.29E-01	1.15E-03	8.02E-04
177A	0.00E+00	2.70E-08	7.71E-02	1.14E-06	0.00E+00	2.71E-08	7.60E-06	1.24E-01	1.29E-05	1.42E-07	3.27E-06	5.17E-06	2.31E-05	3.22E+00	2.87E-02	2.01E-02
177 Abandoned	0.00E+00	1.08E-09	3.08E-03	4.58E-08	0.00E+00	1.08E-09	3.04E-07	4.94E-03	5.14E-07	5.68E-09	1.31E-07	2.07E-07	9.23E-07	1.29E-01	1.15E-03	8.02E-04
213 of 118/5016/213	0.00E+00	2.03E-08	5.80E-02	8.61E-07	0.00E+00	2.03E-08	5.72E-06	9.28E-02	9.66E-06	1.07E-07	2.46E-06	3.89E-06	1.74E-05	2.42E+00	2.16E-02	1.51E-02
301	0.00E+00	4.78E-08	1.37E-01	2.03E-06	0.00E+00	4.79E-08	1.35E-05	2.19E-01	2.28E-05	2.52E-07	5.78E-06	9.16E-06	4.09E-05	5.70E+00	5.08E-02	3.55E-02
302	0.00E+00	2.59E-09	7.42E-03	1.10E-07	0.00E+00	2.60E-09	7.31E-07	1.19E-02	1.24E-06	1.37E-08	3.14E-07	4.97E-07	2.22E-06	3.10E-01	2.76E-03	1.93E-03
302 Old	0.00E+00	7.41E-10	2.12E-03	3.14E-08	0.00E+00	7.43E-10	2.09E-07	3.39E-03	3.53E-07	3.90E-09	8.97E-08	1.42E-07	6.34E-07	8.85E-02	7.88E-04	5.51E-04
303	0.00E+00	2.59E-09	7.42E-03	1.10E-07	0.00E+00	2.60E-09	7.31E-07	1.19E-02	1.24E-06	1.37E-08	3.14E-07	4.97E-07	2.22E-06	3.10E-01	2.76E-03	1.93E-03
304	0.00E+00	3.78E-09	1.08E-02	1.60E-07	0.00E+00	3.79E-09	1.06E-06	1.73E-02	1.80E-06	1.99E-08	4.57E-07	7.24E-07	3.23E-06	4.51E-01	4.01E-03	2.81E-03
3265	0.00E+00	4.70E-08	1.34E-01	1.99E-06	0.00E+00	4.71E-08	1.32E-05	2.15E-01	2.24E-05	2.47E-07	5.69E-06	9.01E-06	4.02E-05	5.61E+00	5.00E-02	3.50E-02
3265-B	0.00E+00	5.41E-10	1.55E-03	2.30E-08	0.00E+00	5.43E-10	1.53E-07	2.48E-03	2.58E-07	2.85E-09	6.55E-08	1.04E-07	4.63E-07	6.46E-02	5.76E-04	4.03E-04
3266	0.000E+00	1.187E-09	3.392E-03	5.035E-08	0.000E+00	1.190E-09	3.344E-07	5.432E-03	5.652E-07	6.248E-09	1.437E-07	2.274E-07	1.016E-06	1.417E-01	1.262E-03	8.825E-04
3275	0.00E+00	4.70E-08	1.34E-01	1.99E-06	0.00E+00	4.71E-08	1.32E-05	2.15E-01	2.24E-05	2.47E-07	5.69E-06	9.01E-06	4.02E-05	5.61E+00	5.00E-02	3.50E-02
3275-B	0.00E+00	5.41E-10	1.55E-03	2.30E-08	0.00E+00	5.43E-10	1.53E-07	2.48E-03	2.58E-07	2.85E-09	6.55E-08	1.04E-07	4.63E-07	6.46E-02	5.76E-04	4.03E-04
3277	0.000E+00	1.187E-09	3.392E-03	5.035E-08	0.000E+00	1.190E-09	3.344E-07	5.432E-03	5.652E-07	6.248E-09	1.437E-07	2.274E-07	1.016E-06	1.417E-01	1.262E-03	8.825E-04
5016 of 118/5016/213+B18	0.00E+00	2.91E-09	8.33E-03	1.24E-07	0.00E+00	2.92E-09	8.21E-07	1.33E-02	1.39E-06	1.53E-08	3.53E-07	5.58E-07	2.49E-06	3.48E-01	3.10E-03	2.17E-03
W320-17-1 9852	0.00E+00	7.41E-10	2.12E-03	3.15E-08	0.00E+00	7.43E-10	2.09E-07	3.39E-03	3.53E-07	3.90E-09	8.97E-08	1.42E-07	6.35E-07	8.85E-02	7.88E-04	5.51E-04
W318-14-2	0.00E+00	7.41E-10	2.12E-03	3.15E-08	0.00E+00	7.43E-10	2.09E-07	3.39E-03	3.53E-07	3.90E-09	8.97E-08	1.42E-07	6.35E-07	8.85E-02	7.88E-04	5.51E-04
3, 4, 5, 6, 7, 8 GDLs	0.00E+00	1.94E-09	5.55E-03	8.24E-08	0.00E+00	1.95E-09	5.47E-07	8.89E-03	9.25E-07	1.02E-08	2.35E-07	3.72E-07	1.66E-06	2.32E-01	2.07E-03	1.44E-03
19 to 18 transfer	0.00E+00	7.77E-09	2.22E-02	3.30E-07	0.00E+00	7.79E-09	2.19E-06	3.56E-02	3.70E-06	4.09E-08	9.40E-07	1.49E-06	6.65E-06	9.27E-01	8.26E-03	5.78E-03
17 to 18 transfer	0.00E+00	5.72E-09	1.63E-02	2.43E-07	0.00E+00	5.73E-09	1.61E-06	2.62E-02	2.72E-06	3.01E-08	6.92E-07	1.10E-06	4.89E-06	6.83E-01	6.08E-03	4.25E-03
Total	0.00E+00	4.75E-07	1.36E+00	2.02E-05	0.00E+00	4.76E-07	1.34E-04	2.17E+00	2.26E-04	2.50E-06	5.75E-05	9.10E-05	4.07E-04	5.67E+01	5.05E-01	3.53E-01

Table 3-4: Summary Table of Transfer Line Contamination (Ci) , cont'd

Line No.(1)	Pu-241	Pu-242	Pu-244	Am-241	Am-242m		Cm-242	Cm-243	Cm-244	Cm-245	Cm-247	Cm-248	Bk-249	Cf-249
1/176A	2.34E-01	2.91E-06	1.34E-08	8.04E-03	1.09E-05	2.83E-06	8.92E-06	1.91E-06	4.29E-05	2.73E-09	3.21E-16	3.34E-16	2.31E-18	1.91E-15
2	3.74E-01	4.65E-06	2.15E-08	1.29E-02	1.74E-05	4.52E-06	1.43E-05	3.05E-06	6.87E-05	4.37E-09	5.13E-16	5.35E-16	3.70E-18	3.05E-15
3	2.01E+00	2.50E-05	1.16E-07	6.91E-02	9.36E-05	2.43E-05	7.67E-05	1.64E-05	3.69E-04	2.35E-08	2.76E-15	2.87E-15	1.99E-17	1.64E-14
4	2.24E+00	2.79E-05	1.29E-07	7.72E-02	1.04E-04	2.71E-05	8.56E-05	1.83E-05	4.12E-04	2.62E-08	3.08E-15	3.21E-15	2.22E-17	1.83E-14
7	4.41E-01	5.49E-06	2.54E-08	1.52E-02	2.06E-05	5.34E-06	1.69E-05	3.61E-06	8.11E-05	5.16E-09	6.06E-16	6.32E-16	4.36E-18	3.61E-15
8	4.41E-01	5.49E-06	2.54E-08	1.52E-02	2.06E-05	5.34E-06	1.69E-05	3.61E-06	8.11E-05	5.16E-09	6.06E-16	6.32E-16	4.36E-18	3.61E-15
11/177A	2.34E-01	2.91E-06	1.34E-08	8.04E-03	1.09E-05	2.83E-06	8.92E-06	1.91E-06	4.29E-05	2.73E-09	3.21E-16	3.34E-16	2.31E-18	1.91E-15
107/117	3.00E+00	3.74E-05	1.73E-07	1.03E-01	1.40E-04	3.63E-05	1.15E-04	2.45E-05	5.52E-04	3.51E-08	4.12E-15	4.30E-15	2.97E-17	2.45E-14
108 (Tk18)	2.10E+00	2.62E-05	1.21E-07	7.23E-02	9.79E-05	2.54E-05	8.03E-05	1.72E-05	3.86E-04	2.46E-08	2.89E-15	3.01E-15	2.08E-17	1.72E-14
118 of 118/5016/213	1.38E+00	1.72E-05	7.95E-08	4.76E-02	6.44E-05	1.67E-05	5.28E-05	1.13E-05	2.54E-04	1.62E-08	1.90E-15	1.98E-15	1.37E-17	1.13E-14
176 Old	9.34E-02	1.16E-06	5.37E-09	3.21E-03	4.35E-06	1.13E-06	3.57E-06	7.63E-07	1.72E-05	1.09E-09	1.28E-16	1.34E-16	9.24E-19	7.63E-16
176A	2.34E+00	2.91E-05	1.34E-07	8.04E-02	1.09E-04	2.83E-05	8.92E-05	1.91E-05	4.29E-04	2.73E-08	3.21E-15	3.34E-15	2.31E-17	1.91E-14
176 Abandoned	1.87E-01	2.33E-06	1.08E-08	6.43E-03	8.70E-06	2.26E-06	7.14E-06	1.53E-06	3.43E-05	2.18E-09	2.57E-16	2.67E-16	1.85E-18	1.53E-15
177 Old	9.34E-02	1.16E-06	5.37E-09	3.21E-03	4.35E-06	1.13E-06	3.57E-06	7.63E-07	1.72E-05	1.09E-09	1.28E-16	1.34E-16	9.24E-19	7.63E-16
177A	2.34E+00	2.91E-05	1.34E-07	8.04E-02	1.09E-04	2.83E-05	8.92E-05	1.91E-05	4.29E-04	2.73E-08	3.21E-15	3.34E-15	2.31E-17	1.91E-14
177 Abandoned	9.34E-02	1.16E-06	5.37E-09	3.21E-03	4.35E-06	1.13E-06	3.57E-06	7.63E-07	1.72E-05	1.09E-09	1.28E-16	1.34E-16	9.24E-19	7.63E-16
213 of 118/5016/213	1.76E+00	2.19E-05	1.01E-07	6.04E-02	8.18E-05	2.13E-05	6.71E-05	1.44E-05	3.23E-04	2.05E-08	2.41E-15	2.51E-15	1.74E-17	1.44E-14
301	4.14E+00	5.15E-05	2.38E-07	1.42E-01	1.93E-04	5.01E-05	1.58E-04	3.38E-05	7.60E-04	4.84E-08	5.68E-15	5.92E-15	4.09E-17	3.38E-14
302	2.25E-01	2.80E-06	1.29E-08	7.73E-03	1.05E-05	2.72E-06	8.58E-06	1.84E-06	4.13E-05	2.63E-09	3.08E-16	3.21E-16	2.22E-18	1.84E-15
302 Old	6.42E-02	7.99E-07	3.69E-09	2.21E-03	2.99E-06	7.77E-07	2.45E-06	5.24E-07	1.18E-05	7.50E-10	8.81E-17	9.18E-17	6.35E-19	5.24E-16
303	2.25E-01	2.80E-06	1.29E-08	7.73E-03	1.05E-05	2.72E-06	8.58E-06	1.84E-06	4.13E-05	2.63E-09	3.08E-16	3.21E-16	2.22E-18	1.84E-15
304	3.27E-01	4.07E-06	1.88E-08	1.13E-02	1.52E-05	3.96E-06	1.25E-05	2.67E-06	6.01E-05	3.82E-09	4.49E-16	4.68E-16	3.23E-18	2.67E-15
3265	4.07E+00	5.07E-05	2.34E-07	1.40E-01	1.90E-04	4.92E-05	1.55E-04	3.33E-05	7.48E-04	4.76E-08	5.59E-15	5.82E-15	4.02E-17	3.33E-14
3265-B	4.69E-02	5.84E-07	2.70E-09	1.61E-03	2.18E-06	5.67E-07	1.79E-06	3.83E-07	8.61E-06	5.48E-10	6.44E-17	6.71E-17	4.64E-19	3.83E-16
3266	1.028E-01	1.279E-06	5.912E-09	3.536E-03	4.787E-06	1.243E-06	3.925E-06	8.396E-07	1.888E-05	1.201E-09	1.411E-16	1.470E-16	1.016E-18	8.397E-16
3275	4.07E+00	5.07E-05	2.34E-07	1.40E-01	1.90E-04	4.92E-05	1.55E-04	3.33E-05	7.48E-04	4.76E-08	5.59E-15	5.82E-15	4.02E-17	3.33E-14
3275-B	4.69E-02	5.84E-07	2.70E-09	1.61E-03	2.18E-06	5.67E-07	1.79E-06	3.83E-07	8.61E-06	5.48E-10	6.44E-17	6.71E-17	4.64E-19	3.83E-16
3277	1.028E-01	1.279E-06	5.912E-09	3.536E-03	4.787E-06	1.243E-06	3.925E-06	8.396E-07	1.888E-05	1.201E-09	1.411E-16	1.470E-16	1.016E-18	8.397E-16
5016 of 118/5016/213+B18	2.52E-01	3.14E-06	1.45E-08	8.68E-03	1.18E-05	3.05E-06	9.64E-06	2.06E-06	4.63E-05	2.95E-09	3.46E-16	3.61E-16	2.49E-18	2.06E-15
W320-17-1 9852	6.42E-02	7.99E-07	3.69E-09	2.21E-03	2.99E-06	7.77E-07	2.45E-06	5.24E-07	1.18E-05	7.50E-10	8.81E-17	9.19E-17	6.35E-19	5.25E-16
W318-14-2	6.42E-02	7.99E-07	3.69E-09	2.21E-03	2.99E-06	7.77E-07	2.45E-06	5.24E-07	1.18E-05	7.50E-10	8.81E-17	9.19E-17	6.35E-19	5.25E-16
3, 4, 5, 6, 7, 8 GDLs	1.68E-01	2.09E-06	9.67E-09	5.79E-03	7.83E-06	2.04E-06	6.42E-06	1.37E-06	3.09E-05	1.97E-09	2.31E-16	2.41E-16	1.66E-18	1.37E-15
19 to 18 transfer	6.73E-01	8.37E-06	3.87E-08	2.31E-02	3.13E-05	8.14E-06	2.57E-05	5.50E-06	1.24E-04	7.86E-09	9.24E-16	9.63E-16	6.65E-18	5.50E-15
17 to 18 transfer	4.95E-01	6.16E-06	2.85E-08	1.70E-02	2.31E-05	5.99E-06	1.89E-05	4.05E-06	9.10E-05	5.79E-09	6.80E-16	7.09E-16	4.90E-18	4.05E-15
Total	4.11E+01	5.12E-04	2.37E-06	1.42E+00	1.92E-03	4.98E-04	1.57E-03	3.36E-04	7.56E-03	4.81E-07	5.65E-14	5.89E-14	4.07E-16	3.36E-13

4.0 CLASS C CALCULATIONS

NDAA Section 3116 establishes the Class C concentration limits of 10 CFR 61.55 as an evaluation criteria for waste determinations. In order to evaluate the status of the 242-F Evaporator System and associated transfer lines, the sum of fractions relative to the Table 1 and Table 2 Class C concentration limits of 10 CFR 61.55 have been calculated based on present conditions and residual inventories. The following is a description of each system component relative to Class C concentration limits.

242-F Evaporator Vessel

The 242-F Evaporator Vessel concentrations were examined based on the residual inventory described in Section 3. The calculations conservatively do not use the vessel itself or internal tubing in the concentration calculations. Table 4-1 presents the comparison to 10 CFR 61.55 Table 1 limits, and Table 4-2 presents the comparison to 10 CFR 61.55 Table 2 limits as taken from (Dixon, 2005). Based on the results, even with the conservative calculations, the 242-F Evaporator Vessel will meet Class C concentration limits with only approximately one inch of grout and would easily meet Class C concentration limits once the vessel and internal tubing were included in the calculations.

Overheads Tanks

The Overheads tanks concentrations were examined based on the residual inventory described in Section 3. The calculations conservatively do not use the vessel itself or internal equipment in the concentration calculations. Table 4-3 presents the comparison to 10 CFR 61.55 Table 1 limits and Table 4-4 presents the comparison to 10 CFR 61.55 Table 2 limits as taken from (Dixon, 2005). Based on the results, even with the conservative calculations, the overheads tanks will meet Class C concentration limits with approximately 20 inches of grout and would easily meet Class C concentration limits without grout once the vessel and internal equipment were included in the calculations.

Concentrate Transfer System Tank

The Concentrate Transfer System (CTS) Tank concentrations were examined based on the residual inventory described in Section 3. The calculations conservatively do not use the vessel itself or internal tubing in the concentration calculations. Table 4-5 presents the comparison to 10 CFR 61.55 Table 1 limits and Table 4-6 presents the comparison to 10 CFR 61.55 Table 2 limits as taken from (Dixon, 2005). Based on the results, the CTS Tank will not meet Class C concentration limits even if filled with grout. Therefore, the path forward for closure of the CTS tank will need to involve further cleaning of the CTS Tank in order to meet Class C concentration limits.

Tanks 17-20 Transfer Lines

The radioactive waste transfer lines associated with the Tanks 17-20 area are predominantly two-inch and three-inch diameter core pipes. The transfer line concentrations were examined based on the residual inventory developed in Section 3 and Rosenberger (2006). The pipe wall volume and mass are used in the concentration calculations. Table 4-7 presents the comparison to 10 CFR 61.55 Table 1 limits and Table 4-8 presents the comparison to 10 CFR 61.55 Table 2 limits for the 3” core piping as taken from Rosenberger (2006). Table 4-9 presents the comparison to 10 CFR 61.55 Table 1 limits and Table 4-10 presents the comparison to 10 CFR 61.55 Table 2 limits for the 2” core piping as taken from Rosenberger (2006). Based on the results, the transfer lines will not meet Class C concentration limits even if filled with grout.

The path forward will involve field sampling of the transfer lines in order to establish a more representative residual inventory. The basis for the existing residual inventory (Caldwell, 2005) was purposely conservative for the fate and transport modeling to demonstrate compliance with performance objectives. The calculations utilized worst-case sludge slurry radionuclide concentrations being used in all transfer lines with a minimum of three volume flushes after transfers. The sampling is anticipated to result in a much lower residual inventory because most of the transfer lines did not transfer sludge materials, all of the sludge material is unlikely to be at the worst case concentrations, and the concentration of transuranic nuclides (which drive the Class C concentrations) were much lower in the typical materials transferred. The more representative residual inventory is anticipated to result in values less than Class C concentration limits without any further cleaning.

Table 4-1: 10 CFR 61.55 Table 1 Comparison For Evaporator Vessel Residuals (Dixon, 2005)

Radionuclides (Long-lived)	Solids Inventory (Ci)	10 CFR 61.55 Class C Limit	Class C Units	Concentration in Class C Units	Factor Relative to Class C Limit	Factor with 1.3" Grout
^{14}C	2.29E-04	8	Ci/m^3	2.02E-01	2.52E-02	1.8E-04
^{14}C in activated metal	(1)	80	Ci/m^3	(1)	(1)	(1)
^{59}Ni in activated metal	(1)	220	Ci/m^3	(1)	(1)	(1)
^{94}Nb in activated metal	(1)	0.2	Ci/m^3	(1)	(1)	(1)
^{99}Tc	1.28E-03	3	Ci/m^3	1.13E+00	3.76E-01	2.7E-03
^{129}I	9.19E-05	0.08	Ci/m^3	8.09E-02	1.01E+00	7.4E-03
^{237}Np	3.62E-06	100	nCi/g	7.24E-01	7.24E-03	1.2E-04
^{238}Pu	5.35E-03	100	nCi/g	1.07E+03	1.07E+01	1.8E-01
^{239}Pu	1.40E-02	100	nCi/g	2.80E+03	2.80E+01	4.6E-01
^{240}Pu	3.09E-03	100	nCi/g	6.18E+02	6.18E+00	1.0E-01
^{241}Pu	4.41E-02	3500	nCi/g	8.82E+03	2.52E+00	4.1E-02
^{242}Pu	4.47E-06	100	nCi/g	8.94E-01	8.94E-03	1.5E-04
^{244}Pu	1.63E-11	100	nCi/g	3.26E-06	3.26E-08	5.4E-10
^{241}Am	4.11E-03	100	nCi/g	8.22E+02	8.22E+00	1.4E-01
^{242m}Am	1.96E-04	100	nCi/g	3.92E+01	3.92E-01	6.5E-03
^{243}Am	2.44E-10	100	nCi/g	4.88E-05	4.88E-07	8.0E-09
^{242}Cm	1.27E-24	20000	nCi/g	2.54E-19	1.27E-23	2.1E-25
^{243}Cm	3.77E-09	100	nCi/g	7.54E-04	7.54E-06	1.2E-07
^{244}Cm	1.36E-08	100	nCi/g	2.72E-03	2.72E-05	4.5E-07
^{245}Cm	9.56E-15	100	nCi/g	1.91E-09	1.91E-11	3.1E-13
^{247}Cm	8.60E-23	100	nCi/g	1.72E-17	1.72E-19	2.8E-21
^{248}Cm	1.99E-23	100	nCi/g	3.98E-18	3.98E-20	6.6E-22
^{249}Cf	5.53E-25	100	nCi/g	1.11E-19	1.11E-21	1.8E-23
			Sum of Class C Factors		57.4	0.9325

(1) Not present in evaporator vessel

Table 4-2: 10 CFR 61.55 Table 2 Comparison For Evaporator Vessel Residuals (Dixon, 2005)

Radionuclides (Short-lived)	Solids Inventory (Ci)	10 CFR 61.55 Class C Limit	Class C Units	Concentration in Class C Units	Factor Relative to Class C Limit	Factor with 1.3" Grout
Total of all nuclides with less than 5 year half-life		(1)	Ci/m^3	(1)	(1)	(1)
^{3}H	1.49E-05	(1)	Ci/m^3	(1)	(1)	(1)
^{60}Co	1.24E-03	(1)	Ci/m^3	(1)	(1)	(1)
^{63}Ni	1.22E+00	700	Ci/m^3	1.07E+03	1.53E+00	1.1E-02
^{63}Ni in activated metal	(2)	7000	Ci/m^3	(2)	(2)	(2)
^{90}Sr	5.54E-02	7000	Ci/m^3	4.88E+01	6.97E-03	5.1E-05
^{137}Cs	9.50E-01	4600	Ci/m^3	8.37E+02	1.82E-01	1.3E-03
			Sum of Class C Factors		1.7	1.26-02

(1) There are no limits established for these radionuclides in Class C waste (2) Not present in evaporator vessel

Table 4-3: 10 CFR 61.55 Table 1 Comparison For Overheads Tanks Residuals (Dixon, 2005)

Radionuclides (Long lived)	Solids Inventory (Ci)	10 CFR 61.55 Class C Limit	Class C Units	Concentration in Class C Units	Factor Relative to Class C Limit	Factor with 20.5" Grout
^{14}C	5.37E-04	8	Ci/m^3	1.27E-03	1.58E-04	3.8E-05
^{14}C in activated metal	(1)	80	Ci/m^3	(1)	(1)	(1)
^{59}Ni inactivated metal	(1)	220	Ci/m^3	(1)	(1)	(1)
^{94}Nb in activated metal	(1)	0.2	Ci/m^3	(1)	(1)	(1)
^{99}Tc	8.98E-04	3	Ci/m^3	2.12E-03	7.06E-04	1.7E-04
^{129}I	2.15E-04	0.08	Ci/m^3	5.07E-04	6.34E-03	1.5E-03
^{237}Np	7.42E-04	100	nCi/g	9.79E-01	9.79E-03	2.2E-03
^{238}Pu	1.81E-02	100	nCi/g	2.39E+01	2.39E-01	5.4E-02
^{239}Pu	6.55E-02	100	nCi/g	8.64E+01	8.64E-01	2.0E-01
^{240}Pu	2.39E-01	100	nCi/g	3.15E+02	3.15E+00	7.2E-01
^{241}Pu	3.17E-02	3500	nCi/g	4.18E+01	1.19E-02	2.7E-03
^{242}Pu	4.03E-03	100	nCi/g	5.32E+00	5.32E-02	1.2E-02
^{244}Pu	3.82E-11	100	nCi/g	5.04E-08	5.04E-10	1.1E-10
^{241}Am	2.95E-03	100	nCi/g	3.89E+00	3.89E-02	8.9E-03
^{242m}Am	4.58E-04	100	nCi/g	6.04E-01	6.04E-03	1.4E-03
^{243}Am	5.71E-10	100	nCi/g	7.53E-07	7.53E-09	1.7E-09
^{242}Cm	2.96E-24	20000	nCi/g	3.91E-21	1.95E-25	4.4E-26
^{243}Cm	8.83E-09	100	nCi/g	1.16E-05	1.16E-07	2.7E-08
^{244}Cm	3.18E-08	100	nCi/g	4.20E-05	4.20E-07	9.5E-08
^{245}Cm	2.24E-14	100	nCi/g	2.96E-11	2.96E-13	6.7E-14
^{247}Cm	2.01E-22	100	nCi/g	2.65E-19	2.65E-21	6.0E-22
^{248}Cm	4.65E-23	100	nCi/g	6.13E-20	6.13E-22	1.4E-22
^{249}Cf	1.29E-24	100	nCi/g	1.70E-21	1.70E-23	3.9E-24
			Sum of Class C Factors		4.4	0.9972

(1) Not present in Overheads Vessels

Table 4-4 10 CFR 61.55 Table 2 Comparison For Overheads Tanks Residuals (Dixon, 2005)

Radionuclides (Short-lived)	Solids Inventory (Ci)	10 CFR 61.55 Class C Limit	Class C Units	Concentration in Class C Units	Factor Relative to Class C Limit	Factor with 20.5" Grout
Total of all nuclides with less than 5 year half-life		(1)	Ci/m^3	(1)	(1)	(1)
^{3}H	1.44E-01	(1)	Ci/m^3	(1)	(1)	(1)
^{60}Co	2.02E-04	(1)	Ci/m^3	(1)	(1)	(1)
^{63}Ni	2.86E+00	700	Ci/m^3	6.75E+00	9.64E-03	2.3E-03
^{63}Ni in activated metal	(2)	7000	Ci/m^3	(2)	(2)	(2)
^{90}Sr	1.30E-01	7000	Ci/m^3	3.07E-01	4.38E-05	1.1E-05
^{137}Cs	2.41E+00	4600	Ci/m^3	5.68E+00	1.24E-03	3.0E-04
			Sum of Class C Factors		1.09E-02	2.6E-03

(1) There are no limits established for these radionuclides in Class C waste (2) Not present in the Overheads Tanks

Table 4-5 10 CFR 61.55 Table 1 Comparison For CTS Tank Residuals (Dixon, 2005)

Radionuclides (Long-lived)	Solids Inventory (Ci)	10 CFR 61.55 Class C Limit	Class C Units	Concentration in Class C Units	Factor Relative to Class C Limit	Factor with 134.7" Grout
^{14}C	1.48E-01	8	Ci/m^3	6.52E-01	8.15E-02	1.2E-03
^{14}C in activated metal	(1)	80	Ci/m^3	(1)	(1)	(1)
^{59}Ni inactivated metal	(1)	220	Ci/m^3	(1)	(1)	(1)
^{94}Nb in activated metal	(1)	0.2	Ci/m^3	(1)	(1)	(1)
^{99}Tc	7.30E-02	3	Ci/m^3	3.21E-01	1.07E-01	1.6E-03
^{129}I	5.94E-02	0.08	Ci/m^3	2.62E-01	3.27E+00	4.8E-02
^{237}Np	3.16E-04	100	nCi/g	6.80E-01	6.80E-03	1.0E-04
^{238}Pu	6.95E-01	100	nCi/g	1.49E+03	1.49E+01	2.3E-01
^{239}Pu	9.80E-01	100	nCi/g	2.11E+03	2.11E+01	3.3E-01
^{240}Pu	2.57E-01	100	nCi/g	5.53E+02	5.53E+00	8.5E-02
^{241}Pu	3.56E+00	3500	nCi/g	7.66E+03	2.19E+00	3.4E-02
^{242}Pu	8.72E-04	100	nCi/g	1.88E+00	1.88E-02	2.9E-04
^{244}Pu	1.05E-08	100	nCi/g	2.26E-05	2.26E-07	3.5E-09
^{241}Am	6.95E-01	100	nCi/g	1.49E+03	1.49E+01	2.3E-01
^{242m}Am	1.27E-01	100	nCi/g	2.73E+02	2.73E+00	4.2E-02
^{243}Am	1.58E-07	100	nCi/g	3.40E-04	3.40E-06	5.2E-08
^{242}Cm	8.18E-22	20000	nCi/g	1.76E-18	8.80E-23	1.4E-24
^{243}Cm	2.44E-06	100	nCi/g	5.25E-03	5.25E-05	8.1E-07
^{244}Cm	8.78E-06	100	nCi/g	1.89E-02	1.89E-04	2.9E-06
^{245}Cm	6.18E-12	100	nCi/g	1.33E-08	1.33E-10	2.1E-12
^{247}Cm	5.56E-20	100	nCi/g	1.20E-16	1.20E-18	1.8E-20
^{248}Cm	1.28E-20	100	nCi/g	2.75E-17	2.75E-19	4.3E-21
^{249}Cf	3.57E-22	100	nCi/g	7.68E-19	7.68E-21	1.2E-22
			Sum of Class C Factors		70.2	0.9997

(1) Not present in CTS vessel

Table 4-6 10 CFR 61.55 Table 2 Comparison For CTS Tank Residuals (Dixon, 2005)

Radionuclides (Short-lived)	Solids Inventory (Ci)	10 CFR 61.55 Class C Limit	Class C Units	Concentration in Class C Units	Factor Relative to Class C Limit	Factor with 134.7" Grout
Total of all nuclides with less than 5 year half-life		(1)	Ci/m^3	(1)	(1)	(1)
^{3}H	1.08E-01	(1)	Ci/m^3	(1)	(1)	(1)
^{60}Co	5.58E-02	(1)	Ci/m^3	(1)	(1)	(1)
^{63}Ni	7.91E+02	700	Ci/m^3	3.48E+03	4.98E+00	7.3E-02
^{63}Ni in activated metal	(2)	7000	Ci/m^3	(2)	(2)	(2)
^{90}Sr	3.58E+01	7000	Ci/m^3	1.58E+02	2.25E-02	3.3E-04
^{137}Cs	4.55E+02	4600	Ci/m^3	2.00E+03	4.36E-01	6.4E-03
			Sum of Class C Factors		5.4	7.95E-02

(1) There are no limits established for these radionuclides in Class C waste (2) Not present in CTS vessel

Table 4-7 10 CFR 61.55 Table 1 Comparison For 3" Line Residuals (Rosenberger, 2006)

Radionuclides (Long-lived)	Solids Inventory (Ci)	10 CFR 61.55 Class C Limit	Class C Units	Concentration in Class C Units	Factor Relative to Class C Limit	Factor with Full Grout
^{14}C	1.51E-09	8	Ci/m^3	3.44E-06	4.30E-07	1.0E-07
^{14}C in activated metal	(1)	80	Ci/m^3	(1)	(1)	(1)
^{59}Ni inactivated metal	(1)	220	Ci/m^3	(1)	(1)	(1)
^{94}Nb in activated metal	(1)	0.2	Ci/m^3	(1)	(1)	(1)
^{99}Tc	2.32E-05	3	Ci/m^3	5.29E-02	1.76E-02	4.08E-03
^{129}I	2.20E-08	0.08	Ci/m^3	5.03E-05	6.28E-04	1.46E-04
^{237}Np	4.62E-08	100	nCi/g	1.31E-02	1.31E-04	7.29E-05
^{238}Pu	6.44E-03	100	nCi/g	1.83E+03	1.83E+01	1.02E+01
^{239}Pu	5.73E-05	100	nCi/g	1.63E+01	1.63E-01	9.05E-02
^{240}Pu	4.01E-05	100	nCi/g	1.14E+01	1.14E-01	6.33E-02
^{241}Pu	4.67E-03	3500	nCi/g	1.33E+03	3.80E-01	2.11E-01
^{242}Pu	5.81E-08	100	nCi/g	1.65E-02	1.65E-04	9.18E-05
^{244}Pu	2.69E-10	100	nCi/g	7.65E-05	7.65E-07	4.24E-07
^{241}Am	1.61E-04	100	nCi/g	4.57E+01	4.57E-01	2.54E-01
^{242m}Am	2.18E-07	100	nCi/g	6.19E-02	6.19E-04	3.43E-04
^{243}Am	5.65E-08	100	nCi/g	1.61E-02	1.61E-04	8.92E-05
^{242}Cm	1.78E-07	20000	nCi/g	5.08E-02	2.54E-06	1.41E-06
^{243}Cm	3.82E-08	100	nCi/g	1.09E-02	1.09E-04	6.02E-05
^{244}Cm	8.58E-07	100	nCi/g	2.44E-01	2.44E-03	1.35E-03
^{245}Cm	5.46E-11	100	nCi/g	1.55E-05	1.55E-07	8.62E-08
^{247}Cm	6.41E-18	100	nCi/g	1.82E-12	1.82E-14	1.01E-14
^{248}Cm	6.68E-18	100	nCi/g	1.90E-12	1.90E-14	1.06E-14
^{249}Cf	4.62E-20	100	nCi/g	1.09E-11	1.09E-13	6.03E-14
			Sum of Class C Factors		19.5	10.8

(1) Not present in transfer lines

Table 4-8 10 CFR 61.55 Table 2 Comparison For 3" Line Residuals (Rosenberger, 2006)

Radionuclides (Short-lived)	Solids Inventory (Ci)	10 CFR 61.55 Class C Limit	Class C Units	Concentration in Class C Units	Factor Relative to Class C Limit	Factor with Full Grout
Total of all nuclides with less than 5 year half-life		(1)	Ci/m^3	(1)	(1)	(1)
^{3}H	5.05E-04	(1)	Ci/m^3	(1)	(1)	(1)
^{60}Co	8.55E-04	(1)	Ci/m^3	(1)	(1)	(1)
^{63}Ni	1.65E-04	700	Ci/m^3	3.77E-01	5.39E-04	1.2E-04
^{63}Ni in activated metal	(2)	7000	Ci/m^3	(2)	(2)	(2)
^{90}Sr	1.65E-01	7000	Ci/m^3	3.76E+02	5.37E-02	1.2E-02
^{137}Cs	2.06E-01	4600	Ci/m^3	4.70E+02	1.02E-01	2.4E-02
			Sum of Class C Factors		0.156	0.0362

(1) There are no limits established for these radionuclides in Class C waste (2) Not present in transfer lines

Table 4-9 10 CFR 61.55 Table 1 Comparison For 2” Line Residuals (Rosenberger, 2006)

Radionuclides (Long-lived)	Solids Inventory (Ci)	10 CFR 61.55 Class C Limit	Class C Units	Concentration in Class C Units	Factor Relative to Class C Limit	Factor with Full Grout
^{14}C	6.88E-10	8	Ci/m^3	3.25E-06	4.07E-07	9.9E-08
^{14}C in activated metal	(1)	80	Ci/m^3	(1)	(1)	(1)
^{59}Ni inactivated metal	(1)	220	Ci/m^3	(1)	(1)	(1)
^{94}Nb in activated metal	(1)	0.2	Ci/m^3	(1)	(1)	(1)
^{99}Tc	1.06E-05	3	Ci/m^3	5.00E-02	1.67E-02	4.05E-03
^{129}I	1.00E-08	0.08	Ci/m^3	4.75E-05	5.94E-04	1.44E-04
^{237}Np	2.11E-08	100	nCi/g	1.24E-02	1.24E-04	7.08E-05
^{238}Pu	2.94E-03	100	nCi/g	1.73E+03	1.73E+01	9.87E+00
^{239}Pu	2.62E-05	100	nCi/g	1.54E+01	1.54E-01	8.79E-02
^{240}Pu	1.83E-05	100	nCi/g	1.08E+01	1.08E-01	6.15E-02
^{241}Pu	2.13E-03	3500	nCi/g	1.26E+03	3.59E-01	2.05E-01
^{242}Pu	2.65E-08	100	nCi/g	1.57E-02	1.57E-04	8.92E-05
^{244}Pu	1.23E-10	100	nCi/g	7.23E-05	7.23E-07	4.12E-07
^{241}Am	7.33E-05	100	nCi/g	4.33E+01	4.33E-01	2.46E-01
^{242m} Am	9.93E-08	100	nCi/g	5.86E-02	5.86E-04	3.34E-04
^{243}Am	2.58E-08	100	nCi/g	1.52E-02	1.52E-04	8.67E-05
^{242}Cm	8.14E-08	20000	nCi/g	4.80E-02	2.40E-06	1.37E-06
^{243}Cm	1.74E-08	100	nCi/g	1.03E-02	1.03E-04	5.85E-05
^{244}Cm	3.91E-07	100	nCi/g	2.31E-01	2.31E-03	1.32E-03
^{245}Cm	2.49E-11	100	nCi/g	1.47E-05	1.47E-07	8.37E-08
^{247}Cm	2.93E-18	100	nCi/g	1.73E-12	1.73E-14	9.83E-15
^{248}Cm	3.05E-18	100	nCi/g	1.80E-12	1.80E-14	1.02E-14
^{249}Cf	2.11E-20	100	nCi/g	1.03E-11	1.03E-13	5.85E-14
			Sum of Class C Factors		18.4	10.5

(1) Not present in transfer lines

Table 4-10 10 CFR 61.55 Table 2 Comparison For 2” Line Residuals (Rosenberger, 2006)

Radionuclides (Short-lived)	Solids Inventory (Ci)	10 CFR 61.55 Class C Limit	Class C Units	Concentration in Class C Units	Factor Relative to Class C Limit	Factor with Full Grout
Total of all nuclides with less than 5 year half-life		(1)	Ci/m^3	(1)	(1)	(1)
^{3}H	3.10E-04	(1)	Ci/m^3	(1)	(1)	(1)
^{60}Co	3.90E-04	(1)	Ci/m^3	(1)	(1)	(1)
^{63}Ni	7.54E-05	700	Ci/m^3	3.57E-01	5.09E-04	1.2E-04
^{63}Ni in activated metal	(2)	7000	Ci/m^3	(2)	(2)	(2)
^{90}Sr	7.51E-02	7000	Ci/m^3	3.55E+02	5.08E-02	1.2E-02
^{137}Cs	9.39E-02	4600	Ci/m^3	4.45E+02	9.66E-02	2.3E-02
			Sum of Class C Factors		0.148	0.0359

(1) There are no limits established for these radionuclides in Class C waste (2) Not present in transfer lines

5.0 PERFORMANCE ASSESSMENT

The Performance Assessment for Tanks 18 and 19 as documented in the Performance Objective Demonstration Document (PODD), (Rosenberger, 2005) evaluated transfer lines and other ancillary equipment as filled with reducing grout. [Note: The Performance Assessment treats the entire 242-F Evaporator System and transfer lines as one ancillary equipment source term for groundwater modeling.] The reducing environment provided by the grout fill slows the release of contaminants into the environment, and has the potential to reduce the dose or delay the time to peak dose. A sensitivity analysis in which the piping and ancillary equipment did not have the reducing environment provided by the grout fill was also performed. The results of this analysis are presented in Table 5-1.

Table 5-1: Sensitivity to Dose with No Grout Fill in Ancillary Equipment

Case	Tc-99 Dose Compared to Base Case	Years to Peak Dose	Np-237 Annual Dose Compared to Base Case	Years to Peak Dose
No grout in ancillary equipment	Negligible Change	595	Negligible Change	6,755
Base Case	--	595	--	6,755

The modeling results show that the piping and other ancillary equipment do not contribute significantly to the total dose. Table 5-1 demonstrates that the piping and ancillary equipment would not impact the dose if it were not filled with reducing grout. The following items would need to be completed to support the performance assessment work associated with the 242-F Evaporator System 3116 Determination:

Additional evaluation of intruder scenarios will need to be performed for the 242-F Evaporator System, i.e., intruder–construction, and intruder–resident.

When the new source term data is available for the 242-F Evaporator System (CTS tank, North and South Overheads tanks) and transfer lines, new groundwater modeling will be performed. Based on the output of this modeling, a new calculation will be performed to establish final all-pathways dose results for comparison against the performance objectives.

6.0 PATH FORWARD

Sufficiency reviews previously conducted associated with the NDAA 3116 Determination process for the 242-F Evaporator System have concluded that additional work related to the Tanks 17-20 transfer lines was needed to demonstrate compliance with the 3116 Determination criteria. The 3116 Determination sufficiency reviews also determined that additional work may be required to complete cleaning the 242-3F Concentrate Transfer System (CTS) pump tank and 242-F Evaporator South and North Overheads Tanks.

As discussed by Dixon (2004), the 242-F Evaporator System Closure Preparation left ~205 gallons of solids material in three of the System's vessels, the CTS tank and the South and North Overheads Tanks. The South Overheads Tank retains ~100 gallons of residual material in the 1200 gallon capacity tank. The North Overheads Tank retains ~ 15 gallons. The CTS tank retains ~90 gallons in the 3000 gallon capacity tank (Waltz, 2004b). It was determined that the activities performed to date to remove the residual solid materials do not meet the 3116 Determination criteria for "maximum extent practical" waste removal. Further waste removal is required to meet current requirements. This further heel removal will require accessing the vessels individually. Additional characterization of the residual source term remaining in the transfer lines is recommended for evaluation against the Class C concentration limits.

A Project Team will be formed to develop and execute all the activities necessary for the 242-F Evaporator System and the Tanks 17-20 related transfer lines to meet the requirements for their closure consistent with 3116 requirements. This Project Team will be formed after the Project has been authorized through the Baseline Change Proposal (BCP) process.
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6.1 Conclusions on Removal to Maximum Extent Practical

A Project Team will be chartered to develop and execute the best approach to stabilizing and closing the Evaporator System. Three preliminary possible alternatives have been identified for 242-F Evaporator System stabilization and closure. Due to radiation fields (0.5 R/hr over the open pit) associated with the CTS, ALARA consideration would be paramount for field work associated with this facility (242-3F). Work with the Overheads tanks would result in some exposure due to rates associated with the receiver cell; however, the rates are lower when compared to the 242-3F, CTS. The following sections briefly describes the actions taken previously to prepare these systems for closure.

6.1.1 242-F Evaporator Vessel

After the 242-F evaporator was declared inoperable, it went through three separate waste removal campaigns beginning in 1988 and ending in 2004. During these series of heel removal efforts, the total free liquid was reduced to ~30 gallons, and the solids were estimated to be ~0.3 gallons. The residual solids (from samples taken) have shown that the 242-F evaporator vessel will meet Class C calculations and will have an insignificant impact on the “all pathways dose” evaluation previously performed.

6.1.2 242-F North and South Overheads Tanks

During the 242-F waste removal campaign described in 6.1.1, much of the initial waste removal efforts resulted in a dilute waste stream being sent through the Overheads tanks. However, during the final waste removal campaign in 2004, the Overheads tanks were pumped out to the lowest levels that could be achieved with the technology employed. The South Overheads tank had ~100 gallons of residual material and the North overheads tank ~15 gallons. Both the North and South Overheads tanks were sampled, and calculations have shown that they will meet Class C concentration limits and will have an insignificant impact on the “all pathways dose” evaluation previously performed. However, it is believed that with the use of alternative residual material removal equipment and the accessibility of both overheads tanks, further waste removal is achievable at an acceptable cost/risk benefit. See Appendix C.

6.1.3 CTS System

During the 242-F waste removal campaign described in 6.1.1, much of the initial waste removal efforts resulted in a dilute waste stream also being sent through the CTS tank as well as the overheads tanks. Since then, the CTS tank has been used as a catch tank for rainwater collection, a non-waste processing function. However, during the final waste removal campaign in 2004, the CTS tank was pumped out to the minimum level that could be achieved with the technology employed. After the pump down ~90 gallons remained in the 3000 gallon capacity CTS tank. The solids were sampled, and calculations have shown that the CTS tank will not meet Class C concentration limits. However, the residual source term associated with these solids will not have a significant impact on the “all pathways dose” evaluation previously performed. With the use of alternative residual material removal technologies and the accessibility of the CTS tank, further waste removal is necessary and achievable. Unlike the Overheads tanks, the cost/risk benefit to achieve more waste removal will come at a much higher value due to the increased radiation rates and difficulty accessing the CTS tank. See Appendix C.

6.1.4 Transfer System

Based on the historical proceduralized transfer line flushing regime- an equivalent three transfer line volume flushes following each waste sludge transfer—the transfer lines are assumed to be contaminated but free of residual sludge. Field surveys conducted for the Tank 18 modification of the Tank 1 to Tank 7 transfer line have supported this assumption. The use of long radius elbows in all transfer lines is an established practice since early SRS construction and serves to minimize sludge separation and hold-up in the line during transfers. Based on the conceptual calculation for the source term for the buried transfer lines, the transfer lines will not meet Class C concentration limits. However, the source term does not have a significant impact on the “all pathways dose” evaluation previously performed. The additional characterization work described below in section 6.2.2 must be completed prior to making a final conclusion on removal to the maximum extent practical.

6.2 Additional Characterization Work

Additional characterization work will be required for the Overheads Tanks, the CTS Tank and the Tanks 17-20 transfer lines. This characterization work will include all necessary sampling, volume estimates of remaining residual solids, and analytical work to develop residual source term after any additional cleaning work has been performed.

6.2.1 242-F Evaporator System

Additional waste removal will be required for the CTS Tank and the Overheads Tanks. After completion of the additional waste removal, the necessary volume estimates, sampling and analysis work must be performed to adequately characterize the residual source term.

6.2.2 Transfer Lines

It is anticipated that no additional waste removal efforts for the transfer lines will be required based on actual samples taken from recent transfer line modification data. However, further characterization of the inventories for the transfer lines will be required to provide a more representative residual inventory than the pessimistic analytical estimate. This will be achieved by physical sampling and video inspections as was done to characterize residual radionuclide inventories for the 242-F Evaporator System equipment and Tanks 17-20. Over 50% of the subject transfer line lengths are accessible via cleanout ports. A statistical analysis (study) will be used to help determine the optimum sampling plan to determine how, where, and how many additional samples from these process areas will need to be taken.

6.3 Class C Requirements

After completion of the characterization work on the 242-F Evaporator System and the Tanks 17-20 transfer lines, Class C calculations will be performed with the new residual waste source terms. In addition, Lessons Learned from the Tank 18/19 3116 Determination review process with the Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE) will be applied to the development of the calculations.

6.3.1 242-F Evaporator System

Initial Class C determinations for the 242-F Evaporator, Evaporator Cell, Receiver Cell, Condenser, and CTS Cell will meet class C concentration limits. Based on sampling, the Overheads Tanks will meet Class C requirements. However, based on sampling, the CTS Pump Tank does not currently meet Class C concentration limits.

6.3.2 Transfer Lines

Initial Class C calculations for the process transfer lines indicate they will not meet Class C concentration limits even when crediting potential stabilizing grout. This calculation is based on the analytically derived source term (Caldwell, 2005). With the additional characterization information obtained from the sampling described in Section 6.2.2 it is anticipated that Class C concentration limits will be met.

6.4 Performance Assessment

A new groundwater modeling run with the new waste characterization information will have to be performed. This modeling run will include an updated all path-ways and intruder analysis.

6.5 Closure Evaluation

Closure of the 242-F Evaporator System and the Tanks 17-20 transfer lines must meet the 3116 criteria.

6.5.1 242-F Evaporator System Closure

Closure of the 242-F Evaporator System will be accomplished by grouting of the Evaporator and associated tanks and equipment.

6.5.2 Transfer Line Closure

Closure of transfer lines in F-Tank Farm has not been performed to date, other than passive fills associated with the grouting of Tanks 17 and 20. Preliminary alternatives for closure of transfer lines from a scoping standpoint can be found in Appendix D.

These alternatives include the following: 1) no stabilization, assuming that the residual waste can be determined to meet Class C concentration limits without grout; 2) passive stabilization where the transfer lines connected to the vessels or other ancillary equipment being stabilized are not isolated and the grout is allowed to flow into the connecting lines; 3) in-situ stabilization involving extensive field work to access each transfer line segment and provide a vent path; and, 4) removal of the transfer line for disposal in a nearby SRS Low Level Waste (LLW) disposal facility.

Characterization of the residual line inventory based on the results of the transfer line sampling is the required first step prior to the final decision on closure of the transfer lines. If the actual transfer line residual inventory can be shown to be much less than the current analytical estimate, then the remaining residual material is anticipated to meet Class C criteria without grout as the grout only reduces concentration limits by less than a factor of 2. The performance assessment results, even using the current pessimistic analytical inventory values for the transfer lines, do not require using reducing grout to meet the performance objectives.

There is a significant amount of technical development work needed to support grouting of the transfer lines. Development of the optimum grout recipe for flowability, injection methods, and establishment of the necessary vent capability are some of the technical issues that must be addressed. Since the performance assessment work has shown that reducing properties are not required to meet the performance objectives, and the grout does not significantly affect Class C concentrations, the option of not filling the transfer lines should be considered. If line stabilization is necessary, then fill material options other than grout should be considered if the alternative materials provide other benefits. The path forward to grouting or filling transfer line jackets will also be evaluated to determine if it is necessary.

6.6 Cost-Benefit Estimates

This document provides several alternatives for additional cleaning or stabilization to meet the 3316 criteria. Descriptions of these alternatives are found in Appendix C and D and summarized below.

6.6.1 Cost-Benefit for the 242-F Evaporator System

As determined above, there are three process areas of the 242-F Evaporator System that require additional waste removal to meet the criteria to the MEP. These three areas are the North and South Overheads tanks and the CTS Tank. Three alternatives were studied: In-situ cleaning (two versions) that would leave the North and South overheads tanks as well as the CTS tank in place, and complete removal/cleaning of the tanks. The in-situ alternatives would require deploying a mixing pump capable of mixing a sand-like residual material and a compatible transfer pump into each tank and then transferring the material to a suitable area. The remove- and-remotely-clean option would physically remove these tanks and transport them to an appropriate cleaning facility.

The rough order of magnitude cost estimate for doing this work ranges from $800,000 to $1,600,000. The estimated total worker radiation exposure for executing these options ranges from 4.8 rem to 14.4 rem.

6.6.2 Cost-Benefit for the Stabilization of Transfer Lines

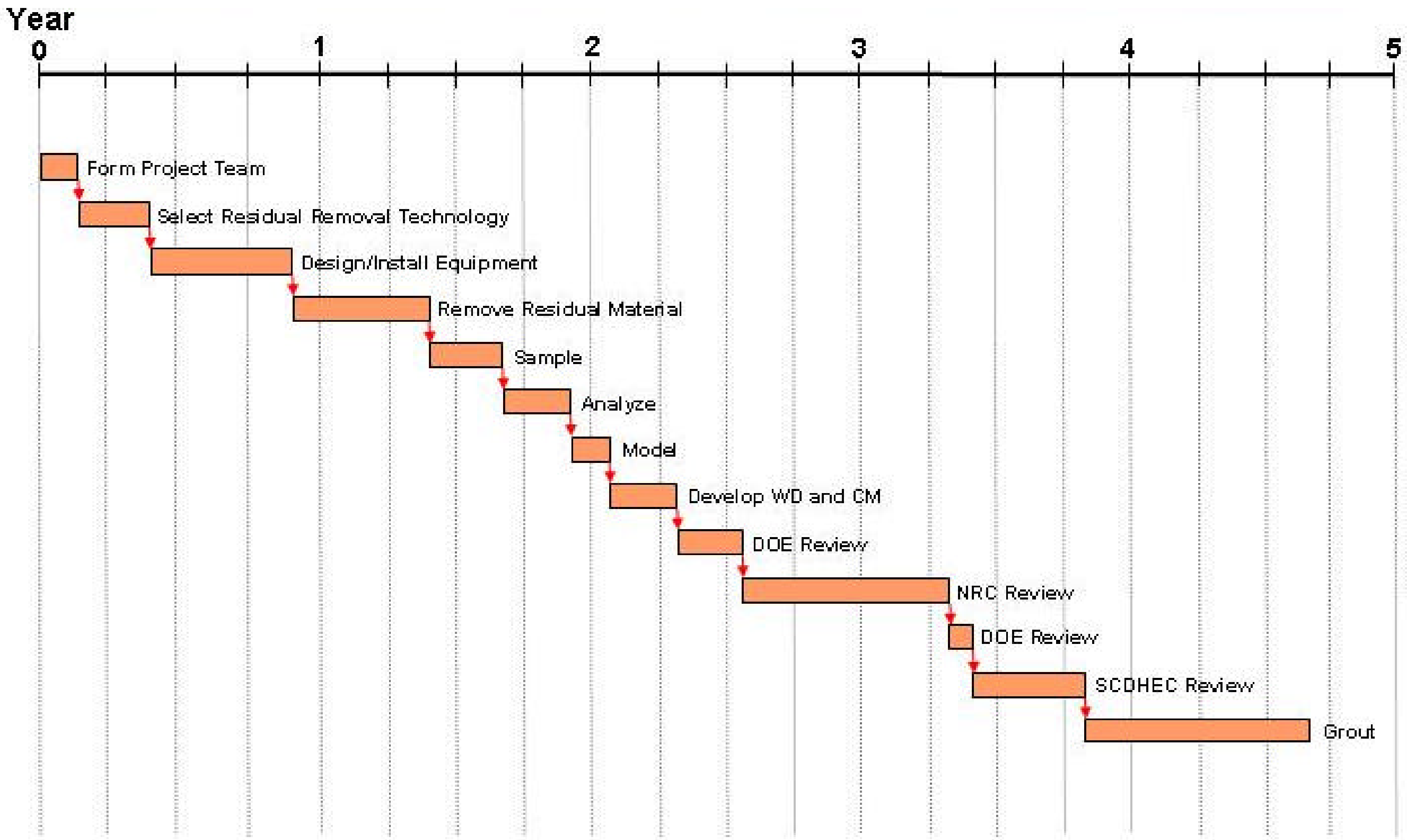
Four likely alternatives have been identified for transfer line stabilization and closure. These options range from performing additional sampling (see 6.2.2) and requiring no stabilization to passive filling of the transfer lines during closure activities to forced injection of a stabilization material (grout) into the transfer lines to complete removal and cleaning of all transfer lines.

The estimated rough order of magnitude cost for doing this work ranges as high as $48,000,000. The estimated total worker radiation exposure for executing these options ranges from 2.4 rem to 6000 rem.

6.7 Schedule

Figure 6-1 shows the proposed schedule for the closure of the 242-F Evaporator System and Tanks 17-20 transfer lines. Year zero would begin with the forming of the Project Team. The Project Team will be formed after the Baseline Change Proposal (BCP) has been approved and accepted by the Department of Energy (DOE).

Figure 6-1: 242-F Evaporator System and Transfer Lines Critical Path Activities



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APPENDIX A

Table A-1 Tanks 17-20 Related Transfer Lines

Segment	Description	Ref	Configuration	Length (ft)	Volume (ft^3)	High Point	High Elevation	Low Point	Low Elevation	Sloped Toward	Stabilization
8	18-20 Cascade Line; Isolated at W320-17-1 Valve Box near Tank 20	W717613	4" core/6" CS jacket	55	5	W320-17-1 Valve Box	270.6	Near 320-17-1 valve box	260.75	Tank 20	Excavation
W318-14-2	18-20 Cascade line LDB near Tank 20	W717613							260.54	NA	Excavation
W320-17-1	Valve Box; 18-20 cascade line	W717613				270.6			270.6	NA	Excavation
7	17-19 Cascade Line; Abandoned in place; cut and capped near tank 19	W717008	4" core/6" CS jacket	55	5		260.66		260.66	NA	Excavation
176 Old	Capped/abandoned in berm between evaporator and Tank 18 SW riser	S5-2-5942 W231025	3" core/6" transite jacket	20	1	At berm slope	277	NearTank 18 SW Riser	268.5	Tk 18	Hi Rad Excavation
177 Old	Capped/abandoned in berm between evaporator and Tank 18 SW riser	S5-2-5942 W231025	3" core/6" transite jacket	20	1	At berm slope	277	NearTank 18 SW Riser	268.5	Tk 18	Hi Rad Excavation
302 Old	Capped/abandoned in berm between evaporator and Tank 18 SE riser	S524952		20						NA	Hi Rad Excavation and locate
176A	CTS valve box to Tank 7 via FDB-6, Nozzle 6 (jumper to Nozzle 1) - Feed	S5925931 S525932 S525942	3" core/4" jacket	300 Evap to FDB-6; 200 FDB-6 to Tank 7	15	CTS Valve Box	274.82	Tank 7	267.87	Tk7	Hi Rad Excavation and locate
177A	CTS valve box to Tank 7 via FDB-6 (jumper to Nozzle 2), Nozzle 5 - vent	S5925931 S525932 S525942	3" core/6" jacket	300 Evap to FDB-6; 200 FDB-6 to Tank 7	15	Tank 7	267.5	CTS Valve Box	263.54	CTS	3 clean out ports (S525969); upstream of FDB6
176 Abandoned	Tank 7 feed from Evaporator; Bypass FDB-6; cut and capped	W701934 S525932	3" core/4" jacket	40	2	Near FDB-6	211	Near FDB-6	210	FDB6	Excavation & tap
177 Abandoned	Tank 7 Return to evaporator; Bypass FDB-6; cut and capped	W701934 S525932	3" core/4" jacket	40	2	Near FDB-6	211	Near FDB-6	210	FDB6	Excavation & tap
1/176A	Evaporator (nozzle 12) to CTS valve box - Feed	S525943 S525970	3" core/4" jacket	50	2	Evaporator	277.12	CTS Valve Box	267.92	CTS	from evaporator; vent via valve box

NOTE: Some of the transfer segments listed in Figure 2-16 are not listed in Appendix A because they were spare tank penetrations that were never used.

Table A-1 Tanks 17-20 Related Transfer Lines (cont'd)

11/177A	Evaporator (Nozzles, 4, 5, 6 & 8) to CTS valve box - vent	S525943 S525970	3" core/4" jacket	50	2	Evaporator	277.12	CTS Valve Box	267.5	CTS	from evaporator; vent via valve box
2	Evaporator to Tank 18 - feed; Jacuzzi pump line	S525970 S521388 W164177	3" core/4/6" jacket	80	4	evaporator	277	Tank 18	274	Tk 18	fill and flush port - Hi rad - on tank 18 SE riser berm
3, 4, 5, 6, 7, 8 GDLs	Evaporator to Tanks 17-20	W231025	3" core/6"steam jacket/12 transite	cut and capped at evap - 6 plcs; cut and capped at tanks - 4 plcs (2 spare)		Evaporator	270	Tank Riser	256	Tk	passive fill from evaporator - remove blanks
301	CTS to Tanks 1-4 loop line	W239840 W236128	2" core/ 6" jacket (includes 1" steam trace and 1-1/2" waste water)	1942	42	Tanks	277	CTS	263	CTS	Line is cut and capped 16' outside CTS. Multiple (5) COPs along path
Misc-1	19 to 18 transfer	S523524	3" core/4" jacket	144	7	Tank 19 NW Riser	267.8	Tank 18 W Riser	267	Tk 18	Excavation & tap
Misc-2	17 to 18 transfer	S523524	3" core/4" jacket	106	5	Tank 17 SW riser	267.6	Tank 18 W Riser	267	Tk	Excavation & tap
302	Tank 18 SW Riser to CTS	W236195	1-1/2" core/4" jacket	70	1	Tank 18	272	CTS	263	CTS	Hi Rad - CTS Access
303	Evaporator to CTS	W236195	1-1/2" core/4" jacket	70	5	Evaporator	280	CTS	262	CTS	Hi Rad Excavation
304	Tank 18 SW Riser to CTS	W236195	3" core/4" jacket	70	3	Tank 18	273	CTS	263	CTS	Hi Rad - CTS Access
118/5016/213	Tank 7 (old Tank 1 transfer line) to Tank 18 NE riser	S525090 mtrdf00017 mm6f4032	3" core/4" jacket	670	33	Tank 7	272	Tank 18 NE Riser	271.88	Tk 18	Access at Tank 18
3 (HP-50E)	FDB1 Nozzle 28 to Tank 18	W163901 W164193	3" core/6" transite jacket	430	21	FDB1	268	Tank 18 Wall penetration	261	Tk 18	Junction box and sump - no access - Prefer Tank 18 empty
4 (HP-51E)	FDB1 Nozzle 29 to Tank 17	W163901	3" core/6" transite jacket	480	24	FDB1	268	Tank 17 Wall penetration	261	Tk 17	Junction box and sump - no access
107/117	Tank 18 East Riser to FDB2 Nozzle 33	W235672 W236672	3" core/4" CS jacket	648	32	FDB2	274	Tank 18	272.32	Tk 18	Access at FDB2
108	From DB3 to Tank 18 via FDB2 Nozzle 32	W235672	3" core/4" CS jacket	450	22	FDB2	274				Access at FDB2/3
3265/C3	Nozzle 1 CTS Loop Line to Tanks 33/34 via FDB5 nozzle 1 jumper to nozzle	W239840 W447075 W702026	2" core/ 4, 6, 8" jacket (includes 1" steam trace and 1-1/2" waste water)	1910	42	Tks 33/34	279.4	CTS	262.54	CTS	7 COPs

Table A-1 Tanks 17-20 Related Transfer Lines (cont'd)

3266	242-F Evaporator to FDB-6 (ties into existing 177A)	W700975, W701934, W702732, W701196, M-M6-F-3357	3" core/6" jacket	22	2					FDB-6	
3275/C1	Nozzle 3 CTS Loop Line return to Tanks 33/34 via FDB5 Nozzle 2	W239840 W447075 W702026	2" core/ 4, 6, 8" jacket (includes 1" steam trace and 1-1/2" waste water)	1910	42	Tks 33/34	279.4	CTS	262.54	CTS	7 COPs
3265 Abandoned	CTS Loop Line to Tanks 33/34 via FDB5	W702026	2" core/ 4, 6, 8" jacket (includes 1" steam trace and 1-1/2" waste water)	22	1						Excavation
3275 Abandoned	CTS Loop Line return to Tanks 33/34 via FDB5	W702026	2" core/ 4, 6, 8" jacket (includes 1" steam trace and 1-1/2" waste water)	22	1						Excavation
3277	FDB-6 to 242-F Evaporator (ties into existing 176A)	W700975, W701934, W702732, W701106, M-M6-F-3357	3" core/6" jacket	22	2					FDB-6	

APPENDIX B

Table B-1 F-Tank Farm Transfer Lines Excluding Tanks 17-20 Related Transfer Lines

Line No.	From	To	Largest Nominal Core Diameter (ins)	Largest Nominal Diameter (ins)	Pipe Length (ft)	Projected Footprint (ft^2)	Pipe Volume (ft^3)	References
2	Tk33(C2) VN	Tk34(C2) VN	2	3	190	37.6	4.4	W239840, W238338, W259468, M-M6-F-3355
73	Tk44 (C1) TJ	Tk26 (C1)	3	10	447	130.4	22.9	W706328, W703325, W701873, M-M6-F-3107, M-M6-F-3111
74	Tk45 (C1) TJ	Tk26 (C1)	3	10	289	84.3	14.8	W706328, W703325, W703416, M-M6-F-3107, M-M6-F-3112
75	Tk46 (C1)	Tk26 (C1)	3	10	404	117.8	20.7	W706330, W703325, W703418, M-M6-F-3107, M-M6-F-3113
76	Tk47(C1)TJ	Tk26 (C1)	3	10	547	159.5	28.1	W706330, W703325, W703418, M-M6-F-3107, M-M6-F-3114
105	Tk27(S) VN	FDB-4(11)	3	10	108	31.5	5.5	W700932, W701016, W701227, M-M6-F-3121, M-M6-F-3108
110	#17015	FDB-2(31)	3	6	285	83.1	14.6	W236672, W236643, M-M6-F-3288, M-M6-F-3349, W714298
111	FDB-2(30)	FDB-3(16)	3	8	57	16.6	2.9	W238273, W706053, W238155, M-M6-F-3353, M-M6-F-3349
112	FDB-2(29)	FDB-3(17)	3	8	67	19.5	3.4	W2017868, W713210, W238318, M-M6-F-3349, M-M6-F-3353
114	FDB-1(30)	FPP-1(1A)	3	8	640	186.7	32.9	W718377, W702321, W238318, M-M6-F-3350, M-M6-F-3359, W702327
115	FDB-1(31)	cut & capped	3	8	10	2.9	0.5	M-M6-F-3359
116	FDB-1(32)	cut & capped	3	8	10	2.9	0.5	M-M6-F-3359
117	FDB-1(33)	cut & capped	3	8	10	2.9	0.5	M-M6-F-3359
118	#5016	#213	3	10	296	86.3	15.2	S5-2-5090, W235672, W709589, M-M6-F-4032
156	Tk34 (C1) VN	FDB-3(2)	3	8	295	86.0	15.1	W238318, W238338, M-M6-F-3353
157	FDB-3(1)	Tk34 (C1) VN	3	8	295	86.0	15.1	W238318, W238338, M-M6-F-3353
161	FDB-3 sump	FDB-2 sump	1.5	4	84	13.3	1.2	M-M6-F-3349, M-M6-F-3353
201	FPP-3(5) pump out	FDB-4(3)	3	0	56	16.3	2.9	W2017868, W701347, M-M6-F-3121, M-M6-F-3119
202	FPP-3(7) TJ	FDB-4(1)	3	0	47	13.7	2.4	W2017868, W701347, M-M6-F-3121, M-M6-F-3119
210	Tk4(6)TJ	#3752	3	10	227	66.2	11.7	W728976,W716927,W716595,W713153, M-M6-F-3583, M-M6-F-3289
211	Tk3(5) TJ	Tk7(6) VN	3	10	272	79.3	14.0	W710315, W713153, M-M6-F-3287, M-M6-F-3288
212	Tk2(3)TJ	Tk7(6) VN	3	10	420	122.5	21.6	W710315, W713153, M-M6-F-3583, M-M6-F-3288
213	#118	Tk7(6) VN	3	10	376	109.7	19.3	W710315, W713153, M-M6-F-3288, M-M6-F-4032
397	Tk25(C1) TJ	Tk26(S)	3	8	312	91.0	16.0	W700764, W701011, W700766, M-M6-F-3107, M-M6-F-3106
497	Tk27(C1) TJ	Tk26(S)	3	10	283	82.5	14.5	W700765, W701018, W700767,M-M6-F-3107, M-M6-F-3108
Line No.	From	To	Largest Nominal Core Diameter (ins)	Largest Nominal Diameter (ins)	Pipe Length (ft)	Projected Footprint (ft^2)	Pipe Volume (ft^3)	References
515	16030	#3754	3	6	60	17.5	3.1	W716598, M-M6-F-3289, M-M6-F-3644
520	Tk5(6)	#3751	3	6	128	37.3	6.6	W713153, W716596, M-M6-F-3289, M-M6-F-3287

Table B-1 F-Tank Farm Transfer Lines Excluding Tanks 17-20 Related Transfer Lines (cont'd)

521	Tk6(6)	#3753	3	6	133	38.8	6.8	W719199, W812719, W716927, M-M6-F-3289, M-M6-F-3626
547	Tk28(C1) valve box	Tk26(S)	3	10	392	114.3	20.1	W700765, W701018, W700767, M-M6-F-3107, M-M6-F-3110
960	Tk25(C2) VN	Tk26(C2)VN	2	6	205	40.6	4.8	W702257,W702033,W702258,M-M6-F-3106,M-M6-F-3107,M-M6-F-3124
1012	Tk26(R2) VN	242-16F evaporator	1	3	133	14.6	0.8	W701836, W703415, W701837, M-M6-F-3024, M-M6-F-3030
1013	Tk26(C2) VN	Tk27(C2) VN	2	6	170	33.6	4.0	W702259, W702260, W702034, M-M6-F-3107, M-M6-F-3124, M-M6-F-3108
1040	Tk26(R1) VN	FDB-6(4)	3	6	491	143.2	25.2	W701848, W702028, W702341, M-M6-F-3357, W700975
1054	Tk27(C2) VN	Tk28(C2) VN	2	6	172	34.0	4.0	W702262, W702126, M-M6-F-3108, M-M6-F-3124, M-M6-F-3110
1104	Tk28(C2) VN	FDB-5(9)	2	10	357	70.7	8.3	W702293, W702294, W702035, M-M6-F-3123, M-M6-F-3124, M-M6-F-3110
1209	3-valve box W328-15-3	Tk28 TTJ	3	6	23	6.7	1.2	M-M6F-3110, W2021381, W818659, W818679
1377	242-16F evaporator (24)	Tk26(C3) VN	2	6	75	14.8	1.7	W701134, W701135, W701403, M-M6-F-3024, M-M6-F-3030
1378	242-16F evaporator (23)	Tk25(C3) VN	2	6	110	21.8	2.6	W701132, W701133, W701402, M-M6-F-3024, M-M6-F-3031
1379	242-16F evaporator (10)	Tk27(C3) VN	2	6	77	15.2	1.8	W701387, W701388, W701407, M-M6-F-3024, M-M6-F-3027
1380	242-16F evaporator (11)	Tk28(C3) VN	2	6	176	34.8	4.1	W702644, W702645, W701408, M-M6-F-3024, M-M6-F-3031
1383	242-16F evaporator (22)	Tk44(C3) VN	2	6	190	37.6	4.4	W706010, W706011, W705722, M-M6-F-3024, M-M6-F-3032
1384	242-16F evaporator (21)	Tk45(C3) VN	2	6	97	19.2	2.3	W706012, W706013, W705723, M-M6-F-3024, M-M6-F-3032
1385	242-16F evaporator (13)	Tk46(C3) VN	2	6	97	19.2	2.3	W706014, W706015, W705724, M-M6-F-3024, M-M6-F-3033
1386	242-16F evaporator (12)	Tk47(C3) VN	2	6	181	35.8	4.2	W706016, W706017, W705725, M-M6-F-3024, M-M6-F-3033
1408	242-16F Evap.	Tk27(M) CRC	1.5	6	115	18.2	1.6	W703008, W703009, W703051, M-M6-F-3026, M-M6-F-3027, M-M6-F-3028
1414	Tk27(M) CRC	242-16F Evap.	1.5	6	115	18.2	1.6	W703008, W703009, W703051, M-M6-F-3026, M-M6-F-3027, M-M6-F-3028
1461	Tk44(C1) TJ	FDB-4(20)	3	10	483	140.9	24.8	W705250, W702129, W702302, M-M6-F-3121, M-M6-F-3111
1462	Tk45(C1) TJ	FDB-4(19)	3	10	340	99.2	17.5	W705250, W702130, W702302, M-M6-F-3121, M-M6-F-3112
1467	Tk46(C1) VN	FDB-4(18)	3	10	685	199.8	35.2	W705253, W702130, W701347, M-M6-F-3113, M-M6-F-3121
1468	Tk47 (C1)	FDB-4(17)	3	10	826	240.9	42.4	W705253, W702130, W701347, M-M6-F-3114, M-M6-F-3121
1472	FDB-3(10)	FDB-4(8)	3	10	150	43.8	7.7	W701347, W701121, W712694, M-M6-F-3121, M-M6-F-3353
1475	#100 (221F)	FPP-3(1)	3	6	434	126.6	22.3	W701552, W701937, W704855,W700782, M-M6-F-3119
1476	#103 (221F)	FPP-3(2)	3	10	650	189.6	33.4	W703322, W703333, W704857, W700782, M-M6-F-3119
1478	#101 (221F)	FPP-2(1)	3	10	650	189.6	33.4	W703322, W703333, W704857, W700782, M-M6-F-3116
1488	#102 (221F)	FPP-2(2)	3	6	161	47.0	8.3	W702671, W702672, W701122, W700782, M-M6-F-3116
3260	FDB-6 sump	FPP-3(3A)	3	6	248	72.3	12.7	M-M6-F-3357, M-M6-F-3119,W702358, W702359, W701791,W700975
3261	Tk33(C2) VN	FDB-5 (3)	2	6	141	27.9	3.3	W239840, W702026, W702734,M-M6-F-3123, M-M6-F-3355
3273	Tk25(C2) VN	FDB-5(10)	2	6	393	77.8	9.2	W702295, W702127, W702032, M-M6-F-3124, M-M6-F-3123, M-M6-F-3106
3274	FDB-5 Waste drain	FPP-2(3)	3	6	124	36.2	6.4	M-M6-F-3116, M-M6-F-3123,W700975,W702543,W701793
3276	Tk34 (C2) VN	FDB-5(4)	2	6	141	27.9	3.3	W239840, W702026, W702734,M-M6-F-3123, M-M6-F-3355
3278	FDB-6(2)	Tk7(1) VN	3	6	192	56.0	9.9	W700975, W701934, W702732, M-M6-F-3357
3751	#520	#3754	3	6	2	0.6	0.1	M-M6-F-3289, W719199
3752	#210	#3754	3	6	2	0.6	0.1	M-M6-F-3289, W719199
3753	#521	#3754	3	6	2	0.6	0.1	M-M6-F-3289, W719199
3754	#515	#109 & #3755	3	6	55	16.0	2.8	M-M6-F-3289, W719199

Table B-1 F-Tank Farm Transfer Lines Excluding Tanks 17-20 Related Transfer Lines (cont'd)

3755	#109 & #3754	#103	3	6	3	0.9	0.2	M-M6-F-3289, W719199, M-M6-F-3350
16030	Tank 8 (6)	#515	3	4	20	5.8	1.0	M-M6-F-3644, P-P1-F-2346, P-R1-F-0004
16075	Tank 8 (6)	LDB-17	3	4	8	2.3	0.4	M-M6-F-3644, P-P1-F-2346, P-R1-F-0004
16076	LDB-17	#515	3	4	12	3.5	0.6	M-M6-F-3644, P-P1-F-2346, P-R1-F-0004
17015	Tk7(4) TTP	#110	3	6	96	28.0	4.9	W2017868, W814578, W814579, M-M6-F-3288, M-M6-F-3614
100 (221F)	221-F	#1475	3	10	1661	484.5	85.3	W713074, W713075, W712364, W700782, M-M6-F-3119
100 (IAL)	FDB-2(26)	HiPt flush pit (6)	3	4	4288	1250.7	220.1	W235672, W714300, W234806, M-M6-F-3310, M-M6-F-3349, M-M6-F-3309
101 (DB4)	FDB-4(5)	FPP-2(6) pump in.	3	0	34	9.9	1.7	W701347, M-M6-F-3121, M-M6-F-3116,
101 (IAL)	HiPt flush pit (4)	FDB-2(25)	3	4	4288	1250.7	220.1	W234806, M-M6-F-3310, M-M6-F-3349, M-M6-F-3309, W712694, W714758
101(221F)	221-F	#1478	3	10	1661	484.5	85.3	W713074, W713075, W712364, W700782, M-M6-F-3116
102 (221F)	221-F	#1488	3	10	1661	484.5	85.3	W713074, W713075, W712364, W700782, M-M6-F-3116
102 (DB2)	FPP-1(5)	FDB-2(35)	3	4	46	13.4	2.4	W236643, W235672, W2017868, M-M6-F-3350, M-M6-F-3349, M-M6-F-3309
102 (DB4)	FDB-4(2)	FPP-3(6) pump in.	3	0	50	14.6	2.6	W2017868, W701347, M-M6-F-3121, M-M6-F-3119
103 (DB2)	FDB-2(36)	FPP-1 (4)	3	4	40	11.7	2.1	W236643, M-M6-F-3350, M-M6-F-3349, M-M6-F-3309
103 (DB4)	FDB-4(7)	FPP-1(1)	3	4	153	44.6	7.9	W718059, W236643, W701123, M-M6-F-3350, M-M6-F-3121
103(221F)	221-F	#1476	3	10	1661	484.5	85.3	W713074, W713075, W712364, W700782, M-M6-F-3119
104 (DB2)	FDB-2(27)	FDB-1(8)	3	4	1000	291.7	51.3	W235672, W236672, W2017868, M-M6-F-3349, M-M6-F-3359
104 (DB4)	FDB-4(9)	FDB-3(9)	3	10	150	43.8	7.7	W701347, W701121, W712694, M-M6-F-3121, M-M6-F-3353
106 (DB2)	FPP-1(2)	FDB-2(28)	3	4	22	6.4	1.1	W236643, W235672, M-M6-F-3349, M-M6-F-3350, W712694
106 (DB4)	Tk28(S) valve box	FDB-4(10)	3	10	538	156.9	27.6	W700932, W701016, W701227, M-M6-F-3121, M-M6-F-3110
107 (DB4)	Tk26(C1) TJ	FDB-4(13)	3	10	118	34.4	6.1	W700928, W701014, W700782, M-M6-F-3107, M-M6-F-3121
108 (DB2)	FDB-2(32)	FDB-3(15)	3	4	80	23.3	4.1	W238338, W238427, M-M6-F-3349, M-M6-F-3353
108 (DB4)	Tk25(C1) TJ	FDB-4(16)	3	8	323	94.2	16.6	W700782, W701013, W713153, M-M6-F-3106, M-M6-F-3121
109 (DB2)	FDB-2(37)	#3754 & #3755	3	8	60	17.5	3.1	W718172, M-M6-F-3289, M-M6-F-3349
109 (DB4)	FDB-4(12)	Tk26(C1) VN	3	10	118	34.4	6.1	W700928, W701014, W700782, M-M6-F-3107, M-M6-F-3121
110 (cut)	Tk7(2)	cut & capped	3	4	23	6.7	1.2	W814578, M-M6-F-3288
118 (DB1)	FDB-1(7)	cut & capped	3	10	519	151.4	26.6	M-M6-F-3359
151 (DB3)	Tk33(NW)VN	FDB-3(4)	3	8	190	55.4	9.8	W238318, W238338, W238155, M-M6-F-3353
151 (DB4)	FPP-2(5) pump out	FDB-4(6)	3	0	46	13.4	2.4	W701347, W700566, W2017868, M-M6-F-3121, M-M6-F-3116
152 (DB3)	FDB-3(3)	Tk33(NW)VN	3	8	190	55.4	9.8	W238318, W238338, W238155, M-M6-F-3353
152 (DB4)	FPP-2(7) TJ	FDB-4(4)	3	0	36	10.5	1.8	W701347, W713770, W700566, M-M6-F-3121, M-M6-F-3116
213 (DB2)	#109 (DB2)	cut & capped	3	4	9	2.6	0.5	M-M6-F-3349
213 (Tk1)	Tk1(3)TJ	cut & capped	3	10	34	9.9	1.7	M-M6-F-3287
3267	Tk7 (1) VN	FDB-6(1)	3	6	192	56.0	9.9	W700975, W701934, W702732, M-M6-F-3357
				Total	34,533	9746.2	1677.4	

APPENDIX C

Appendix C: Summary of Evaporator System Alternatives and Costs

Alternatives

ES 1. In situ. The In situ alternative would require deploying a mixing pump capable of mixing a sand-like residual material and a compatible transfer pump and transfer line. For the CTS tank, the pumps must fit through an 8" hole, make an immediate 90 degree turn and translate horizontally for about 18" before lowering 8' to reach the CTS tank bottom. For the North and South Overheads Tanks, the pumps must fit through a 3” hole, similarly translate horizontally and lower 6’ to the tank bottom. In both cases the horizontal translation is required to clear internal cooling coils. Utilities for the pumps would require design and construction as would the transfer line required to remove the material. Disposal of the pumps and transfer line would also be a design consideration.

Risk: High dose rates at the CTS pit will result in high personnel exposure.

ES 2. Modified In situ. Remove agitator (both tanks) and work through ~2' diameter access ports. While providing ample room for equipment deployment and removing the need for horizontal translation capability, this alternative requires relocating agitators during heel removal. The agitator could be returned to the tank when heel removal is completed. Pumps and transfer lines as required in Alternative ES1 would be required under ES2. In order to provide crane access to the Receiver Cell where the South Overheads tank and agitator are located, the Spray Wash Skid positioned between Tanks 17 and 19 and east of the evaporator cell will require relocation as will the slick line (grout placement) for Tank 19.

Risk: High dose rates at the CTS pit will result in high personnel exposure.

ES-3. D&R and Return. In this alternative, the CTS tank and the North and South Overheads Tank would be removed and shipped to appropriate Decon Facility for cleaning. Once cleaned, the vessels would be returned to their original F-Tank Farm locations for stabilization and closure. This alternative would require locating or developing container(s) for both vessels for the shipment to and from appropriate Decon Facility. In order to provide crane access to the receiver cell where the South Overheads tank is located, the Spray Wash Skid located between Tanks 17 and 19 east of the evaporator cell will require relocation as will the slick line (grout placement) for Tank 19. Other factors requiring consideration for the CTS tank closure include process/service jumpers that have been abandoned in the 242-3F pit. The pit may contain as many as two full sets of CTS tank-to-wall process jumpers from closure preparation and past modifications. A determination is required on whether these jumpers will remain during CTS pit closure and be subject to passive stabilization or removed to provide stabilization fill effectiveness (absence of voids). Removal will require careful planning as it is possible that the jumpers have become entangled and lifting one jumper may result in the movement (and possible lifting) of multiple jumpers. The impact on the CTS pit liner should a jumper fall will require evaluation.

Risk: High dose rates at the CTS pit will result in high personnel exposure.

Cost Estimates

The cost estimates of the 242-F Evaporator System equipment alternatives were derived from Dixon (2004) and prorated for 3 vessels rather than 4. Table C-1 summarizes the cost estimates for each of the alternatives. The differences between Alternatives ES1 and ES2 are related to handling the agitators from the CTS and South Overheads tanks. Since pumps and pump deployment are not required for Alternative ES3, equipment and associated costs are negated.

Table C-1 Summary Table of the 242-F Evaporator System Alternatives Cost Estimates ($1,000)

	Alt. ES1	**Alt. ES2**	**Alt. ES3**
Design and Engineering	$600	$700	$150
Build/install	$390	$490	$200
Remove Equipment	$134	$134	$134*
Evaporation	$74	$74	0
Sampling	$165	$165	$65
Operations	$200	$200	$200
Total	$1,600	$1,800	$800

*Return vessel to containment

APPENDIX D

Appendix D Summary of Transfer Line Alternatives and Costs

Alternatives

A Project Team will be chartered to develop and execute the best approach to stabilizing and closing the transfer lines. Four preliminary possible alternatives have been identified for transfer line stabilization and closure.

TL-1. No Stabilization. Based on the historical proceduralized flushing regime—three line volume flushes following each waste sludge transfer—the transfer lines are assumed to be contaminated but free of residual sludge and no additional waste removal would be required. Field surveys conducted during the Tank 18 modification of the Tank 1 to Tank 7 transfer line have supported this assumption. The use of long-radius elbows in all transfer lines is an established practice since early SRS construction and serves to minimize sludge separation and hold-up in the line during transfers. Additional sampling would be required to support this option.

TL-2. Passive stabilization. Passive stabilization is a process of stabilizing lines by leaving intact segments that connect to tanks/vessels that are being stabilized for closure. The stabilizing medium would be "allowed" to flow passively into the connecting transfer lines. This methodology has previously been employed for Tanks 17 and 20. For maximum passive filling, each connecting line would require venting. Venting a transfer line requires airborne contamination control either by venting to an existing tank/vessel with an operating ventilation system or by installing ventilation equipment or by accepting the release as part of the F-Tank Farm's air quality permit.

Risk 1: Passive stabilization has not been shown effective over long line lengths and may offer little more stabilization efficiencies than Alternative TL1, No Stabilization.

Risk 2: Gravity flow of stabilizing grout into a closed or vented line can result in an unacceptable airborne release at either the vent or point of insertion.

TL-3. In situ stabilization. In situ stabilization involves injecting a stabilizing medium into the transfer line. The technology is available as used in electrical/plumbing applications. For longer line segments, injection points may need to be spaced to ensure adequate fill. In-situ stabilization would require entry into some tank/vessel/containment structures for access to transfer line segment connections. Development work would be required to establish specifications for processing equipment (injection pumps, mixing systems, and venting). Excavations and "hot taps" may be required for additional injection points where cleanout ports are not available on transfer line segments of considerable length. Quality Assurance/Quality control

(QA/QC) methodologies to determine fill effectiveness (absence of voids) requires development if stabilization efficiency and effectiveness metrics are established. Some development work would be required in the areas of stabilization material (grout mix for flowability and reducing properties), injection methods (direct or catheter) and airborne release controls associated with venting. It is anticipated that extensive and concentrated field work management and facility coordination would be required when this alternative is implemented in the field.

Risk 1: Fill efficiencies (fill lengths) are not assured. Some preliminary work by SRNL (Langton, et al., 2003) have indicated >95% effectiveness can be achieved in 60' lengths of PVC pipe; no field testing of transfer line stabilization has been preformed for the segment lengths expected by this alternative.

Risk 2: Forced injection of stabilizing grout into a closed or vented transfer line can result in an airborne release at either the vent or point of injection.

Risk 3: Forced injection of stabilizing grout into a closed or vented line can result in line pressurization leading to failure. While the lines are jacketed, and a failed line would vent into the jacket space, the possibility of an airborne release is a risk. It is assumed the jackets are vented.

TL-4. D&R. The D&R alternative involves the complete removal of the transfer line segments, i.e., excavation, hot tap and foam at cut lines (contamination control), removal and disposition of line segments (burial ground). This alternative provides the highest reduction in residual contamination (within F-Tank Farm) and requires the highest investment of resources in terms of dollars and exposure; however, pragmatically it is waste relocation.

Risk: High personnel exposure and project costs associated with accessing, cutting and disposing of the transfer lines.

Cost Estimates

Cost estimates were developed based on the modification of the Tank 1 to Tank 7 transfer line associated with Tank 18 Heel Removal. This modification required an excavation ~40' in length. Engineering cost for this modification was ~$51,000; the Construction cost ~$151,000.

There were no construction costs associated with Alternative TL1 as no field activities would be required. Alternative TL2 would require reentry into the 242-F Evaporator System to remove connector blanks to permit passive filling and therefore incur some engineering and construction costs.

Alternative TL3 was estimated using a total of 53 excavations (total length of transfer lines in F-Tank Farm divided into ~200' increments). This is based on an assumption that any excavation/hot tap would permit filling in either direction for about 100'. This assumption requires some development work for substantiation. The 53 excavations were evaluated based on the Tank 18 modification (Tank 1 to Tank 7 transfer line) project rate.

Alternative TL4 was estimated again using the Tank 18 modification project estimates. The trench for the tank modification was estimated to be ~40'. This length trench would be repeated 240 times to uncover the full length of Tanks 17-20 grouping related transfer lines. The tank modification cost estimates were increased proportionally. Table D-1 summarizes the cost estimates for each of the alternatives.

Table D-1 Summary Table of Transfer Line Alternatives Cost Estimates ($1,000)

	Alt. TL1	Alt. TL2	Alt. TL3	Alt. TL4
Development		$150	$150	0
Design and Engineering		$300	$2,700[1]	$12,000[3]
Construction		$300	$8,000[2]	$36,000[4]
Totals	N/A*	$750	$10,850	$48,000

1. $51,000 per excavation, 53 excavations estimated
2. $151,000 per excavation point, 53 excavations estimated
3. $51,000 per excavation, 240 excavations estimated
4. $151,000 per excavation, 240 excavations estimated.

* No sampling cost included.

Additional considerations are provided by Alternative TL3. Some of the line segments (177A, 301, 3265/C3 and 3275/C1) in the Tanks 17-20 grouping have cleanout ports periodically along their lengths. These segments represent 66% of the total length of transfer lines in the Tanks 17-20 grouping. A total of 27 clean-out ports exist on these line segments; however, the cleanout ports are not spaced equidistant as they were installed not for line filling but for line cleaning. Nevertheless, considerable cost savings may be possible when these cleanout ports are utilized in lieu of excavation and hot tap.

Table D-2 lists estimated costs and exposures for the transfer line alternatives. Alternative TL4 places a high exposure cost on complete transfer line removal, as would be expected. Alternative TL1 exposure costs are considered a conservative baseline with exposure related to isolation of transfer line segments with normal tank closure processes. The Alternative TL1 exposure costs are considered already incurred as the Tanks 17-20 grouping related transfer line segments have previously been isolated. Alternative TL2 would require additional exposure over Alternative TL1 as the isolation of the line segments would be removed in order to support passive line stabilization. Alternative TL3 is expected to yield the highest stabilization effectiveness but with a significant increase in exposure. It is expected that actual exposures would be less than those estimated for planning purposes as work control practices would be improved with field experience.

Table D-2 Comparison Table of Transfer Line Alternatives Cost-Benefit

	Alt TL1	Alt TL2	Alt TL3	Alt TL4
Total Cost ($100K)	1,700	800	10,900	48,000
Anticipated Exposure (rem)	2.4[1]	4.8	25K[2]	6000K

[1] Actualized during 242-F Evaporator System Closure Preparation Project.
[2] Based on Tank 18 modification to Tank 1 to Tank 7 transfer line actuals, i.e., dose rate/estimated construction hours, multiplied by the expected number of excavations.