SRR-CWDA-2014-00020
Revision 0

Tanks 5 and 6 Final Configuration Report for F-Tank Farm at the Savannah River Site

July 2014

Prepared by: Savannah River Remediation LLC
Regulatory Management & Administration
Aiken, SC 29808

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

APPROVALS

Author:

Bruce Martin
Regulatory Management & Administration
Savannah River Remediation LLC

7/21/14
Date

Technical Review:

LaMesha Pressley
Regulatory Management & Administration
Savannah River Remediation LLC

7/21/14
Date

Robert Voegtlen
Sampling, Isolation, & Grouting
Savannah River Remediation LLC

7/22/14
Date

Management Review:

Mark Mahoney
Regulatory Management & Administration
Savannah River Remediation LLC

7/23/14
Date

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACROYNMS

BW	Bearing Water
CM	Closure Module
DOE	United States Department of Energy
FCR	Final Configuration Report
FFA	Federal Facility Agreement
FTF	F-Tank Farm
GCP	General Closure Plan
H&V	Heating and Ventilation
MCL	Maximum Concentration Limit
PA	Performance Assessment
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site
V	Valve
WTS	Waste Transfer System

1.0 EXECUTIVE SUMMARY

The United States Department of Energy (DOE) documented completion of operational closure of Tanks 5 and 6 located in the F-Tank Farm (FTF) on December 19, 2013. [WDPD-14-16] The final as-built configuration of the closed waste tanks is in accordance with the isolation process and stabilization strategy described in the *Industrial Wastewater Closure Module for the Liquid Waste Tanks 5F and 6F F-Area Tank Farm, Savannah River Site,* SRR-CWDA-2012-00071, (hereinafter referred to as: Tanks 5 and 6 Closure Module [CM]) with minor exceptions/clarifications described within this document. Each waste tank has been isolated from the waste transfer system (WTS) and FTF support systems. Based on visual inspections performed and recorded during grouting, and estimated grout volume delivered to the waste tanks and annuli, no appreciable void space is present inside the waste tanks. In-tank equipment and cooling coil void space was sufficiently filled with grout based on actual grout volume delivered as compared to calculated void space.

This final configuration report (FCR) is submitted to meet the requirements of the *Industrial Wastewater General Closure Plan for F-Area Waste Tank Systems,* LWO-RIP-2009-00009, (hereinafter referred to as: FTF General Closure Plan [GCP]), the Tanks 5 and 6 CM, and to satisfy requirements of Section IX of the Savannah River Site (SRS) Federal Facility Agreement (FFA). [SRR-CWDA-2012-00071, WSRC-OS-94-42] The purpose of this report is to document the final configuration of the closed Tanks 5 and 6 in FTF at SRS. Field conditions that differ from those described in the Tanks 5 and 6 CM, as approved by South Carolina Department of Health and Environmental Control (SCDHEC) April 25, 2013, are herein described. [SRR-CWDA-2012-00071, DHEC_04-25-2013]

2.0 INTRODUCTION/BACKGROUND

The submittal of this FCR satisfies the requirement in Section 3.3.8 of the FTF GCP, which states: "Following completion of stabilization of the individual waste tank system, DOE will provide a Final Configuration Report to SCDHEC describing the final configuration of that system." [LWO-RIP-2009-00009] This FCR includes certification by South Carolina Professional Engineers that all work has been completed in accordance with the approved FTF GCP and Tanks 5 and 6 CM. [LWO-RIP-2009-00009] This FCR primarily addresses tank isolation, stabilization, and future monitoring information discussed in the Tanks 5 and 6 CM.

The Tank 5 and 6 CM describes the processes by which DOE has removed waste from Tanks 5 and 6, sampled residual contaminants, characterized remaining residual inventory, and isolated the tanks from the FTF facilities that remain operable. Submittal of this Final Configuration Report for Tanks 5 and 6 to SCDHEC (as described in the GCP) describes with certification that the removal from service activities for Tanks 5 and 6 have been performed in accordance with the FTF GCP (LWO-RIP-2009-00009) and the Tanks 5 and 6 CM. Sections of the Tanks 5 and 6 CM applicable to this FCR, for which it addresses, are described below:

Closure Configuration - Describes the end state of the waste tanks, including the following:

- Waste tank system isolation process and final configuration of the waste tank system
- Description of structures and equipment that are part of this removal from service activity including any equipment that will remain in a waste tank

- Stabilization strategy including type and characteristics of fill material, as appropriate

Maintenance and Monitoring - Describes maintenance and monitoring requirements for stabilized waste tanks following operational closure. [SRR-CWDA-2012-00071]

Tanks 5 and 6 are part of the group of eight Type I waste tanks (Tanks 1 through 8) in FTF. These waste tanks have a nominal capacity of 750,000 gallons and are approximately nine feet below grade. The primary liner of Type I waste tanks is made of 0.5-inch thick carbon steel. The carbon steel shell sits inside a 22-inch thick reinforced concrete vault with a 2.5-foot annular space surrounding the primary tank. Lining the bottom of the vault for secondary containment is a 5-foot high 0.5-inch thick carbon steel annulus pan to collect leakage, if any, from the primary tank. Type I waste tanks are 75 feet in diameter and are 24.5 feet tall. Each Type I tank has 12 concrete filled steel columns to support the roof. These columns have an outer diameter of two feet of 0.5-inch carbon steel pipe filled with concrete and welded to the roof and floor of the primary tank. Cooling coils in Type I waste tanks are configured in both a horizontal and a vertical array. Each Type I waste tank contains 34 vertical cooling coils that are supported from the primary tank roof by hanger and guide rods. The lower horizontal cooling coil is approximately one inch above the primary tank floor and the upper horizontal cooling coil is approximately four inches above the primary tank floor. In addition, there are supply pipes that connect the tank top cooling water system to the cooling coils. There are approximately 22,800 linear feet of 2-inch diameter carbon steel cooling coil pipes in a Type I waste tank. [SRR-CWDA-2012-00071]

Figures 2.0-1 and 2.0-2 depict the cross section and plan view outlining the general arrangement of waste tank equipment, respectively. The figures depict equipment typical of a Type I tank and are not intended to represent a specific waste tank configuration.

Figure 2.0-1: Typical FTF Type I Tank Cross Section

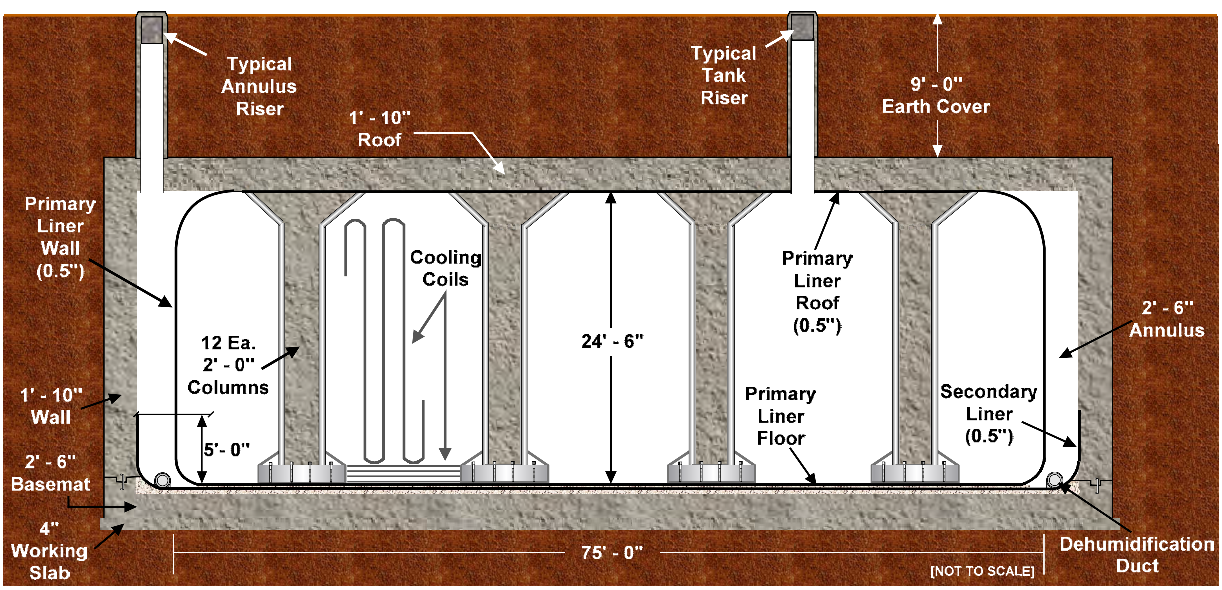
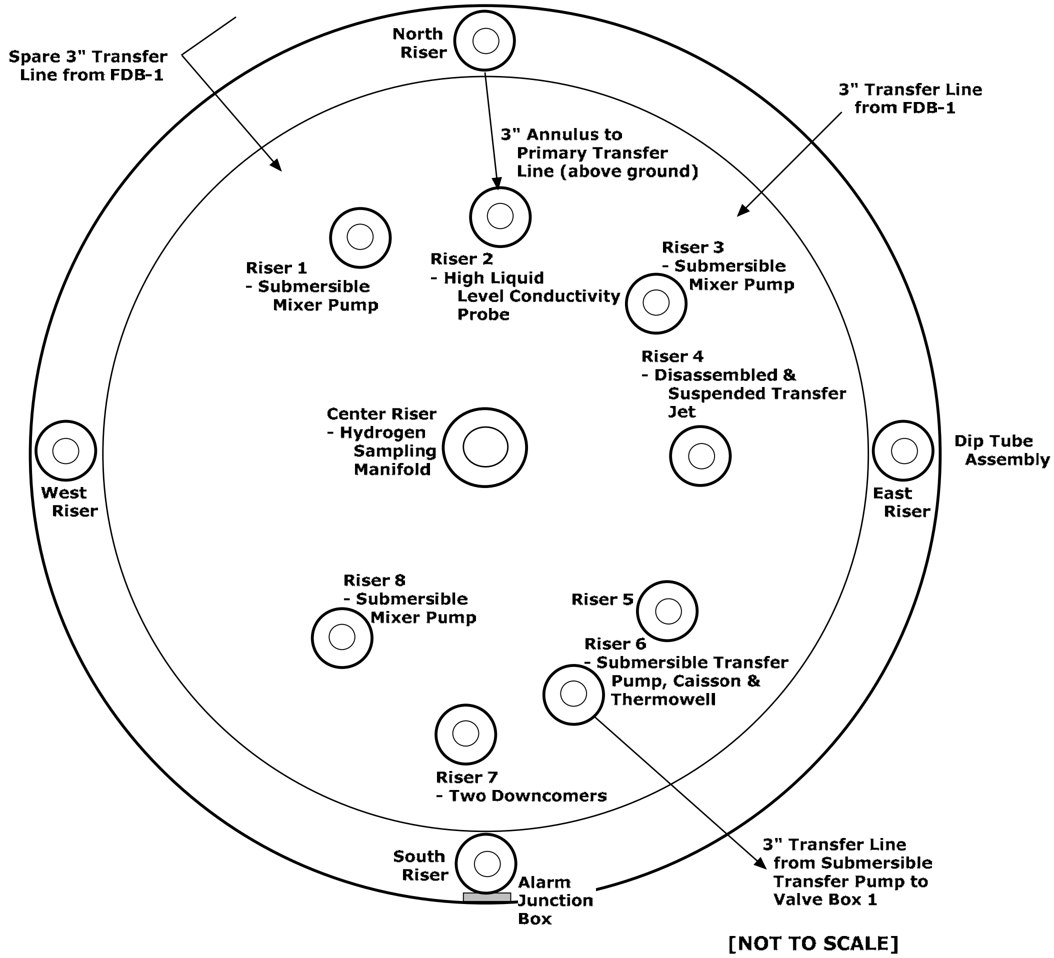


Figure 2.0-2: Typical FTF Type I Tank Plan View



3.0 SUMMARY OF ISOLATION AND GROUTING ACTIVITIES

3.1 Isolation

Tanks 5 and 6 were isolated in accordance with the Tanks 5 and 6 CM Section 7.1 and are consistent with their respective waste tank closure isolation plans except as noted in Section 3.1.1 of this FCR. Mechanical and electrical isolation consisted of demolition and removal of piping and components, plugging lines, removal of equipment, identifying components as “Out Of Commission,” and removing obstructions from and around the risers. [M-CTP-F-00005 and M-CTP-F-00006] Both waste tanks were isolated from the FTF WTS and the FTF support systems (e.g., water, steam, air). The isolation strategy consisted of identification and isolation of transfer lines, drain lines, water, air, and steam supply lines, ventilation lines, power and instrumentation lines, and all other penetrations into or out of the waste tank. Isolation of these systems was performed at the electrical control rooms or field locations for electrical and instrumentation and at the system supply headers located off the tank top for mechanical systems. For example, Figure 3.1-1 shows a bearing water supply line that has been cut and plugged to isolate the bearing water system at Tank 5.

Figure 3.1-1: Tank 5 Bearing Water Supply Pipe Isolated (Tank 5)

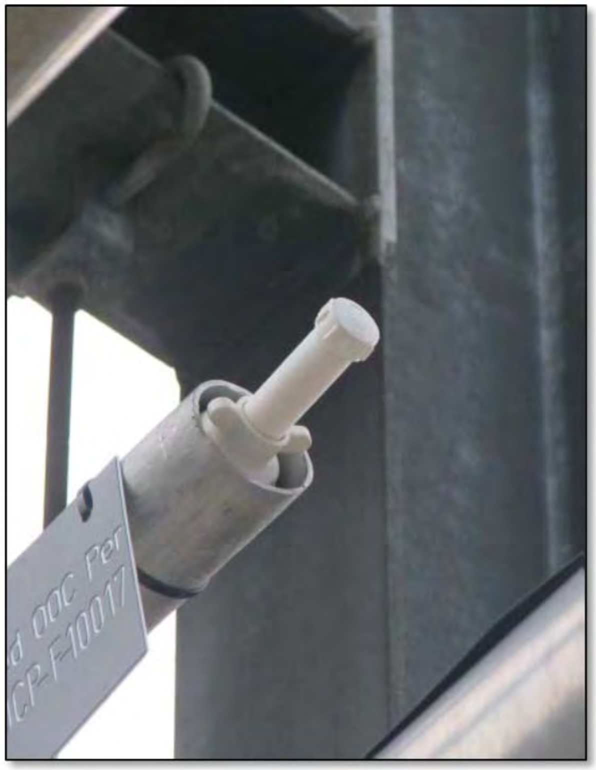
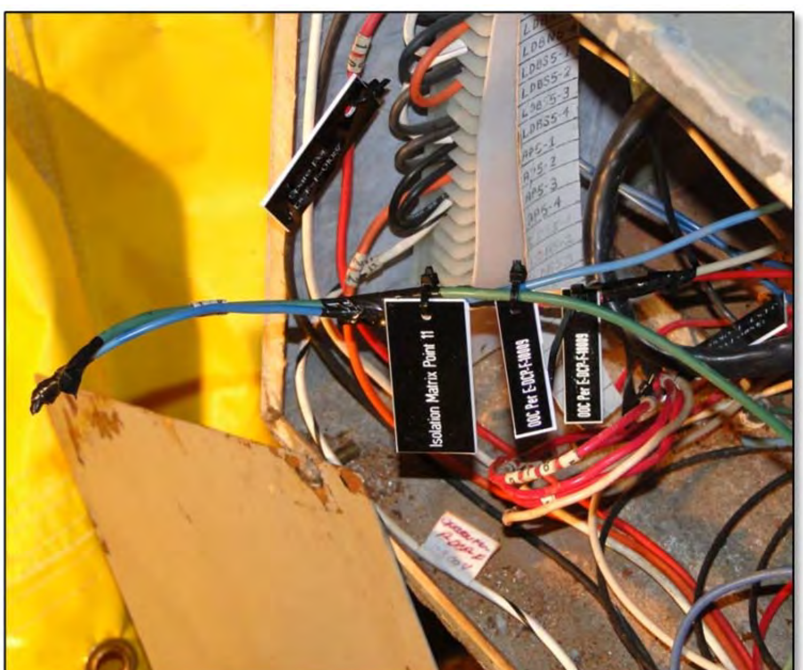


Figure 3.1-2 shows an example of electrical isolation of annulus conductivity probe wiring on Tank 5.

Figure 3.1-2: Electrical Isolation at a Junction Box on Tank 5



Waste tank isolation includes cutting or blanking mechanical system components (e.g., transfer lines, water piping, air piping, steam piping) and disconnecting electrical power to all components on the waste tank. Descriptions of mechanical isolation in Tank 5 are found in M-TRT-F-00031. The descriptions of electrical isolation are found in E-DCP-F-10009 and other miscellaneous design documents listed in SRR-LWE-2013-00227. Descriptions of mechanical isolation in Tank 6 are found in M-TRT-F-00032. The descriptions of electrical isolation are found in E-DCP-F-10010 and other miscellaneous design documents listed in SRR-LWE-2013-00227. These design packages (e.g., design changes, work instructions, and radiological control checklists) may be retrieved from SRS Records Management to provide details of the isolation modifications, if needed. The waste tanks were closed to waste processing activities by isolating transfer lines or plugging/capping the piping, thereby creating a physical break from the rest of the waste tank system.

FFA Assessment Reports are required for modifications to specified waste tank systems and components. FFA Assessment Reports associated with isolation of Tanks 5 and 6 are M-ESR-F-00196 (removal of Tank 5 annulus level conductivity probes and isolation of the annulus steel wall thermocouple) and M-ESR-F-00197 (removal of Tank 6 annulus level conductivity probes and isolation of the annulus steel wall thermocouple). Upon isolation from the transfer system the waste tanks were prepared for operational closure.

3.1.1 Exceptions/Clarifications to Isolation Plans

Exceptions/clarifications from the isolation discussion in Section 7.1 of the Tanks 5 and 6 CM are described below:

- The development of both mechanical and electrical isolation matrices was discussed; however, only mechanical isolation matrices were developed for Tanks 5 and 6. The electrical isolation was performed under design change packages (E-DCP-F-10009 and E-DCP-F-10010) and other miscellaneous design documents as described above. Electrical isolation matrices were determined to be unnecessary because the information was included in the design and did not require duplication in matrices.

- The removal of all tank top heating and ventilation (H&V) equipment was discussed; however, a total of fourteen components of H&V equipment were not removed from the tank top. For example, the Tank 5 annulus inlet filter housing did not interfere with any closure activities and was not removed from the tank top. A listing of the fourteen H&V components that were not removed from the tank top can be found in SRR-LWE-2013-00227. All H&V equipment on Tanks 5 and 6 (while not removed) were isolated.

- Isolation points at specific valve locations were identified. However, in eight cases, isolation was performed downstream of the specified valves. For example, the Tank 5 isolation strategy describes isolation of the bearing water (BW) system at valve (V) BW-V-36; however, actual isolation was performed by cutting and plugging the pipe downstream of BW-V-36. A listing of the eight cases where isolation was performed downstream of the specified valves can be found in SRR-LWE-2013-00227.

- Two contamination control/decontamination agents (non-hazardous solutions of *SC-200*, MSDS-42027, and *ETGS Invisible Blue* [Blue Fog], MSDS-34146) were used during equipment removal/isolation activities on Tanks 5 and 6. The use of these agents and the potential for this material to be introduced into the waste tanks/annuli was evaluated prior to their application. These agents were applied as a fine mist at the upper regions of the risers. Work practices did not allow worker observation through the risers into the waste tank, so the amount of agent material that entered the waste tank was indeterminate. However, it is likely that no significant amount of material entered due to the misting application technique.

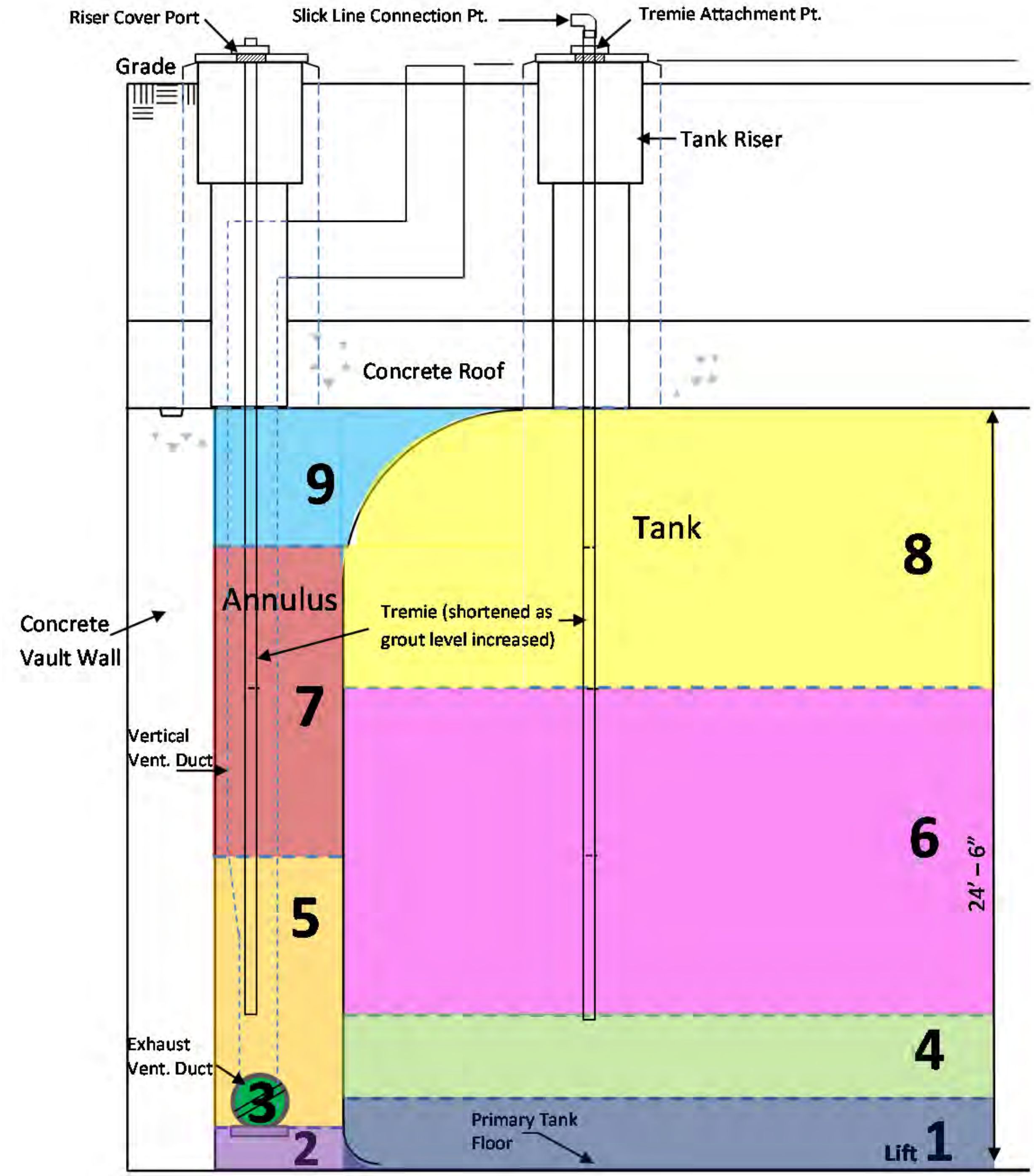
The non-hazardous solution, *SC-200*, MSDS-42027, was used in small quantities (less than 25 gallons total) for contamination control during the removal of three submersible mixer pumps from Tank 6. The second non-hazardous solution, *ETGS Invisible Blue* (Blue Fog), MSDS-34146, was used in small quantities (less than five gallons total) as a "fog" to coat the inside surfaces of risers for contamination control during riser preparations for grouting on Tanks 5 and 6. Prior to use of these solutions, evaluations of SC-200 and ETGS Invisible Blue determined that the potential introduction of these relatively small quantities into the waste tanks/annuli would not impact grout performance or inventory assumptions in the closure documents and compliance with performance objectives would remained unchanged. [TRC-FTF-2012-00013, TRC-FTF-2012-00009]

3.2 Grouting

Grouting activities were completed on Tank 5 and Tank 6 on December 12, 2013, and December 18, 2013, respectively. Tanks 5 and 6 were grouted in accordance with the Tanks 5 and 6 CM, consistent with the *Grout Strategy for Tanks 5 and 6 Closure*. [SRR-LWE-2012-00087]

A structural analysis of the stresses on the tank primary liner anticipated during placement of grout in the tank was performed. [T-CLC-F-00496] As a result, a grout sequence comprised of nine lifts was developed which cycled grouting at specific heights between the tank primary vessel and tank annulus. See Figure 3.2-1 for the grouting sequence of the nine lifts that was followed for Tanks 5 and 6.

Figure 3.2-1: Grout Sequence for Tanks 5 and 6



3.2.1 Tank Interior Bulk Fill Summary

Reducing grout was used to fill the entire volume of the Tank 5 and Tank 6 interior. Tank interior bulk fill was comprised of lifts 1, 4, 6, and 8 (Figure 3.2-1). Grout was added to the waste tanks using portable grout pumps filled from cement mixer trucks. The pumps pushed the grout through slick lines to risers of each waste tank. Camera inspections of the interior of the waste tanks were typically performed and recorded at the beginning, middle, and end of each day during the grouting process. These inspections indicated that the reducing grout flowed over the residual material to stabilize and immobilize it at the bottom of the waste tanks. The grout adequately flowed from the risers around internal obstructions (support columns and cooling coils) to other areas of the waste tank (Figures 3.2-2 and 3.2-3).

Figure 3.2-2: Bulk Fill Grout in Tank 5 during the Filling Process (Lift 4)

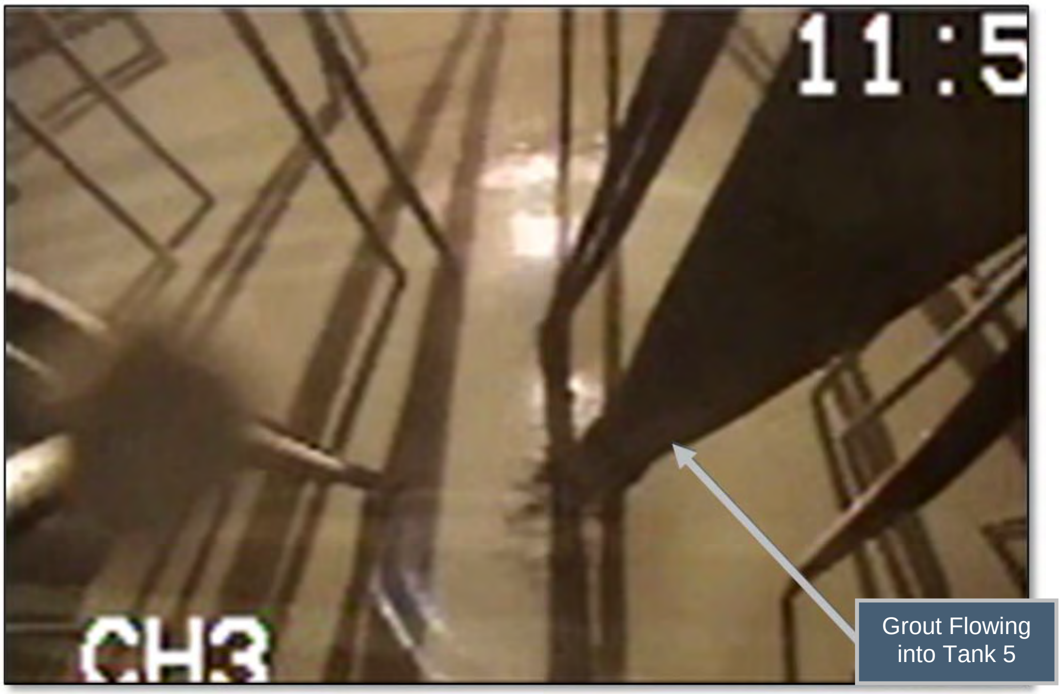


Figure 3.2-3: Bulk Fill Grout in Tank 5 during the Filling Process (Lift 8) Simultaneous Camera Views from Four Risers

Due to a partial stop work because of a lapse of appropriations, grout operations were suspended in Tank 6 from September 27, 2013, until October 30, 2013. [CMD-14-001] Grout operations were suspended in Tank 5 from October 3, 2013, until October 28, 2013. A camera inspection was performed on October 22, 2013, to assess the condition of the grout after curing for 26 days in Tank 6 and 19 days in Tank 5. There was no evidence of void spaces, cracking or shrinkage of the grout in the interior of Tanks 5 and 6 (Figure 3.2-4)

Figure 3.2-4: Grout Conditions on October 22, 2013, in Tanks 5 and 6 after Suspended Grout Operations

It was estimated that 3,927 cubic yards of grout would be required to fill Tank 5 and 3,922 cubic yards of grout would be required to fill Tank 6. (Note: Residual material in each waste tank [1,900 gallons in Tank 5 and 3,000 gallons in Tank 6] was accounted for in the estimated volume of grout to fill the interior of each waste tank.) Approximately 3,871 cubic yards of grout were poured in Tank 5, and approximately 3,849 cubic yards of grout were poured in Tank 6. The actual volume of grout used to fill each waste tank aligned well with the estimated volume. The very similar volume of grout used to fill each waste tank provides further evidence of the absence of significant voids. The actual volume of grout is estimated based on the number of grout trucks and a nominal volume of 8 cubic yards per truck. The exact volume of each grout truck was not verified. Some trucks may have contained more than 8 cubic yards, which may have resulted in the recorded volumes (3,871 and 3,849 cubic yards) being underestimated. Quality control of grout production and delivery was implemented in accordance with the grout procurement specification. [C-SPP-F-00055] The quality control program included documentation of grout component compliance with specified standards, testing of grout test cylinders, and surveillance and audits of grout production and delivery activities. During the grouting process, multiple grout test cylinders were collected from approximately every 100 cubic yards. A total of 374 grout test cylinders (total from both waste tanks) were tested for compressive strength. The average 28-day compressive strength was 2,966 pounds per square inch, well above the value of 2,000 pounds per square inch described in the Tanks 5 and 6 CM. [SRR-LWE-2013-00227]

3.2.1.1 Exceptions/Clarifications to Tank Interior Bulk Fill Grouting Plans

The exceptions/clarifications to bulk fill grouting plans specified in the Tanks 5 and 6 CM are described as follows:

The grout specification required that test cylinders be cured in a controlled environment (temperature and humidity), and be tested for compressive strength at 7 days and 28 days. [C-SPP-F-00055] Due to equipment failure, there were approximately three weeks when the temperature and humidity in the curing room could not be verified. Due to the partial stop work, 17 test cylinders were not tested for compressive strength within the required timeframe.

Additionally, the grout specification required that the total quantity of water in any batch not exceed 48.5 gallons per cubic yard. [C-SPP-F-00055] A review of the grout batch tickets determined that the grout placed into Tank 6 on September 19, 2013, had a water volume that was slightly in excess of the grout specification requirement. The water overage in the grout was less than 3% of the target value of 48.5 gallons per cubic yard. Approximately 200 cubic yards (25 trucks) of grout affected by the water volume overage were placed in Tank 6 during Lift 6. This represents about 5% of the estimated total interior bulk fill grout volume (3,922 cubic yards). The water overage occurred because an incorrect value was inadvertently entered into the mix formula at the batch plant at the beginning of the day. The grout cylinders from the grout poured on September 19, 2013, met compressive strength requirements. [USQ-FTF-2013-00317]

Corrective actions to prevent future occurrences included increased QC inspections at the batch plant and refresher training for personnel responsible for reviewing batch tickets to improve recognition of non-conforming items.

These exceptions to the grout specification were evaluated against relevant assumptions in the FTF Performance Assessment (PA) (hereinafter referred to as: FTF PA). The evaluation determined that these testing and water quantity exceptions did not affect the assumptions in the FTF PA as briefly described herein. The assumptions pertain to the grout performance with respect to 1) grout chemical properties, 2) waste tank stability and 3) waste tank flow modeling. The FTF PA assumptions regarding chemical properties are based on the quantity of slag. The quantity of slag conformed to the grout specification, so the grout chemical properties were determined not to be impacted by the exceptions to the testing specifications. While these 17 cylinders were not tested in the prescribed timeframe, waste tank stability was not impacted because subsequent compressive strength testing on the affected cylinders showed all cylinders to be above

2,000 pounds per square inch (greater than the 500 pounds per square inch value in the FTF PA). The grout formula was developed to meet assumed waste tank flow modeling properties. With the exception of the water volume, the grout formula conformed to grout specification requirements; therefore, the exceptions to the testing specifications did not affect waste tank flow modeling. [TRC-FTF-2013-00320] Additionally, testing performed during the development of the bulk fill grout formulation showed that water to cement ratio variability by the slight amounts that occurred in Tank 6 on September 19, 2013, does not impact the FTF PA properties assumed for waste tank flow modeling. [USQ-FTF-2013-00317]

3.2.2 Annulus Bulk Fill Summary

Annulus bulk fill was performed in Tank 5 from August 21, 2013, to November 18, 2013, and in Tank 6 from August 21, 2013, to November 20, 2013. Annulus bulk fill was comprised of lifts 2, 3, 5, 7 and 9 (Figure 3.2-1).

The annulus ventilation ducts were filled with grout by pouring grout into the air supply location at the tank top. Grout was observed flowing in the ducts and filling the ducts through the registers (6-inch by 14-inch openings in the top of the duct). In areas where grout may not have completely filled the duct, grout was expected to flow into the registers to fill the interior of the duct. Grout flowing into the registers during annulus bulk fill was observed in locations that could be viewed with cameras. (Figure 3.2-5).

Figure 3.2-5: Grouting the Tank 5 Annulus Ventilation Duct (Lift 3)

It was estimated that 583 cubic yards of grout would be required to fill the each of the Tanks 5 and 6 annuli. Approximately 612 cubic yards of grout were poured in the Tank 5 annulus and approximately 601 cubic yards of grout were poured in the Tank 6 annulus. The waste tank interior bulk fill grout formulation was also used for the annulus and annulus duct (Figure 3.2-6). The actual volume of grout used to fill each annulus aligned well with the estimated volume. The very similar volume of grout used to fill each annulus provides evidence of the absence of significant voids. As with tank interior bulk fill, the actual volume of grout poured in each annulus is estimated based on the number of grout trucks and a nominal volume of 8 cubic yards per truck. There were no exceptions/clarifications associated with grouting of the annulus, annulus duct and annulus risers.

Figure 3.2-6: Annulus Bulk Fill Grout in Tank 6 during the Filling Process (Lift 5)

3.2.3 Equipment Fill Summary

The in-tank equipment internals were grouted utilizing a pre-blended mix designed and tested to flow into and fill small void spaces. Due diligence was exerted to inject the highly flowable grout into the equipment to ensure that voids were filled as much as reasonably possible. Preparations at the risers were implemented to facilitate effective grouting of equipment. Grout flow into equipment was improved by venting equipment by drilling holes in the equipment or by removing components from equipment. When required, multiple attempts to fill equipment were made as the grout was allowed to flow and settle over time. [SRR-LWE-2013-00227] Calculated fill volumes of the internal void space of in-tank equipment was compared to actual grout volumes injected into the equipment. See Table 3.2-1. Calculated fill volumes are theoretical values based on assumptions about internal void space and potential grout flow paths. When required, special tools (e.g., angled grout addition lines and hand pump) were used to meet the unique challenges associated with equipment grouting. [SRR-LWE-2013-00227] Work instructions for equipment fill allow flexibility to employ special tools as each specific equipment configuration warrants. Overhead interferences warranted the use of an angled grout addition line to provide a vertical path for the grout to flow into the transfer jet in Tank 6 Riser 4. Experience has shown that equipment fill is more successful when grout enters equipment from the vertical direction. The remaining equipment on Tanks 5 and 6 did not require an angled grout addition line. A hand pump was used to add grout to all equipment in Tanks 5 and 6. The pressure and flow of the grout was controlled with the hand pump to optimize equipment fill. The equipment grout was delivered from buckets of a known volume. The actual grout volume values listed in Table 3.2-1 are based on the volume of buckets poured.

Table 3.2-1: In-Tank Equipment Calculated vs. Actual Grout Fill Comparison

Equipment	Location	Calculated Fill Volume (Gallons)	Actual Grout Volume (Gallons)
Submersible Transfer Pump and caisson	Tank 5, Riser 6	13.4	11
Thermowell	Tank 5, Riser 6	1.6	2
Submersible Transfer Pump and caisson	Tank 6, Riser 6	13.4	11
Thermowell	Tank 6, Riser 6	1.6	2
Transfer Jet	Tank 6, Riser 4	9.5	12
Thermowell	Tank 6, Riser 4	1.5*	1.5

* Fill volume based on 1 inch diameter pipe estimated to be 35 feet long.

As noted in the *Grout Strategy for Tanks 5 and 6 Closure*, SRR-LWE-2012-00087, the goal for grouting in-tank equipment was to minimize the potential for vertical fast flow paths down through the grout to the residual material on the tank floor. The grout placed in the submersible transfer pump in Tank 5, Riser 6, the submersible transfer pump in Tank 6, Riser 6, the transfer jet in Tank 6, Riser 4, and other equipment grouted in the closed waste tanks minimized the potential for vertical fast flow path through this equipment to the waste tank floor.

In essence, the objective of the equipment fill efforts was to practice due diligence to ensure that as much grout as practical was placed into the equipment. Equipment grouting efforts did not cease until the equipment was unable to receive any more grout. Examples of due diligence included the formulation and testing of very flowable grout and the testing of equipment filling techniques by conducting equipment fill trials using mock-ups of some of the equipment anticipated to be more challenging to fill with grout. Equipment mock-ups were constructed of transparent material so that grout flow through the equipment could be assessed. Grout delivery flow rate, settling time, and venting methods are examples of equipment filling techniques that were identified during mock-up testing and implemented during the grouting of in-tank equipment.

Based on this comparison, shown in Table 3.2-1, the filling of internal void space of in-tank equipment was acceptable.

3.2.3.1 Exceptions/Clarifications to Equipment Grout Fill Plans

The following exceptions/clarifications to the in-tank equipment grout plans specified in the Tanks 5 and 6 CM are described below. [SRR-LWE-2013-00227]

- Based on evidence available prior to grouting Tank 6, the transfer jet in Tank 6, Riser 4 was identified as being partially disassembled and suspended above the tank floor. This transfer jet is described as "disassembled" and "not accessible to grout" in Table 7.2-2 of the Tanks 5 and 6 CM.

  During bulk fill grouting, daily in-tank camera inspections were performed from as many as four risers. During one of these routine daily inspections this transfer jet was found to be intact. The intact transfer jet was determined to be accessible to grout and was filled with approximately 12 gallons of grout as noted in Table 3.2-1. [SRR-LWE-2013-00214]

- In addition to the identification of the intact transfer jet described above, a disassembled thermowell assembly was also identified in Tank 6, Riser 4 during routine daily camera inspections during bulk fill grouting. This thermowell assembly had not been previously identified and is not listed in Table 7.2-2 of the Tanks 5 and 6 CM. The disassembled thermowell assembly was determined to be accessible to grout and was filled with 1.5 gallons of grout as noted in Table 3.2-1. [SRR-LWE-2013-00214]
- The Wilden Transfer Pump in the Tank 6 south annulus riser is described in Table 7.2-2 of the Tanks 5 and 6 CM as extending "from riser to floor." In fact, all components of the Wilden Transfer Pump were disconnected from the top of the annulus and lowered to the annulus floor.
- The alarm junction box in the Tank 6 annulus is described in Table 7.2-2 of the Tanks 5 and 6 CM as being located below the south annulus riser. In fact, the alarm junction box is located below the north annulus riser.

3.2.4 Cooling Coil Grouting

Specially formulated and previously tested cooling coil grout was mixed in a hopper near the tank tops. [WSRC-STI-2008-00298] A small pump (versus the larger capacity auger used for bulk fill) delivered the grout into the cooling coils.

<u>Failed Cooling Coil Grouting</u>

Failed cooling coils were grouted successfully from each end (inlet and outlet) as per the requirements of the grout strategy. [SRR-LWE-2012-00087] Cooling coils were identified as "failed" when a significant amount of water was observed exiting from holes or breaks in the piping during flushing. Grouting of failed cooling coils was deemed to be successful when grout was observed exiting the failed coil into the waste tank. Tank 5 had seven failed coils, while Tank 6 had nine failed coils.

<u>Intact Cooling Coil Grouting</u>

Intact cooling coils were grouted from the inlet end of the coil. Grout addition continued until grout exited the outlet end of the coil.

The actual grout volumes placed in the intact cooling coils are based on readings obtained from an in-line flow meter located on the grout addition line. The volume to fill each coil was estimated recognizing that supply and return piping to the coils was installed "field to fit" and the actual length of piping was not documented. The estimated volume to fill each cooling coil is therefore considered a rough estimate. [SRR-LWE-2013-00214]

The estimated volume to fill the intact cooling coils in Tank 5 was 15.6 cubic yards and 14.6 cubic yards grout was used. The estimated volume to fill the intact cooling coils in Tank 6 was 14.7 cubic yards and 13.4 cubic yards of actual grout was used.

3.2.4.1 Exceptions/Clarifications to Cooling Coil Grouting

The following exceptions/clarifications to the cooling coil grouting are described below. [SRR-LWE-2013-00227]

- A total of five of the 56 intact cooling coils in Tanks 5 and 6 were not fully grouted due to complications encountered during the coil grouting process. [SRR-LWE-2013-00214]

    - Tank 5, Cooling Coil 17 (3 gallons of an estimated 107 gallons approximately 3% filled)
    - Tank 5, Cooling Coil 18 (40 gallons of an estimated 148 gallons approximately 27% filled)
    - Tank 6, Cooling Coil 24 (13 gallons of an estimated 99 gallons approximately 13% filled)
    - Tank 6, Cooling Coil 36 (7 gallons of an estimated 148 gallons approximately 5% filled)
    - Tank 6, Cooling Coil 16 (75 gallons of an estimated 107 gallons approximately 70% filled)

    The FTF PA and supporting documentation recognized that cooling coils would be filled to the extent practical with the potential for a limited number of cooling coils to be partially filled. The limited number of partially filled cooling coils in Tanks 5 and 6 does not represent a change to the waste tank final configuration assumptions in closure documentation. [SRR-CWDA-2012-00051]

    Tank 5 cooling coils 17 and 18 were not fully grouted because the grout addition piping became plugged with debris and/or hardened grout. Changes to the cooling coil grouting process (e.g., more flushing, addition of screens to capture debris and larger diameter line cleaning device) were implemented to prevent this type of pluggage during subsequent coil grouting operations.

    Tank 6 cooling coils 24 and 36 were known to have holes, but were considered intact because they were not severed or extensively damaged. It is likely that bulk fill grout entered these holes and plugged these coils to prevent them from being fully filled with cooling coil grout.

    As grout was inserted into the inlet end of each cooling coil, water from previous flushing activities would exit the outlet end of the coil into a container at the tank top. Radiation rates associated with the exiting flush water in Tank 6 cooling coil 16 were higher than expected. Following radiation control protocols, cooling coil grouting was stopped due to the higher rates. [SRR-LWE-2013-00214]

- As noted above, when grout was inserted into the inlet end of each cooling coil, water from previous flushing activities would initially exit the outlet end of the coil into a container at the tank top. To ensure all water had exited and only grout remained in each cooling coil, an additional 35 gallons of grout was added to each cooling coil after the initial transition from water to 100% grout was observed exiting the cooling coil. This practice was not followed for two cooling coils because an insufficient quantity of cooling coil grout was formulated and staged. The quantity of grout needed was underestimated because the length of supply/return piping was underestimated. Supply/return piping was field run and not specifically documented on drawings. The quantity of staged cooling coil grout was increased for the remaining cooling coil grouting in Tanks 5 and 6.

- Tank 5, Cooling Coil 14 was only given an additional 15 gallons of grout after 100% grout was observed exiting the cooling coil
- Tank 5, Cooling Coil 16 was only given an additional 25 gallons of grout after 100% grout was observed exiting the cooling coil

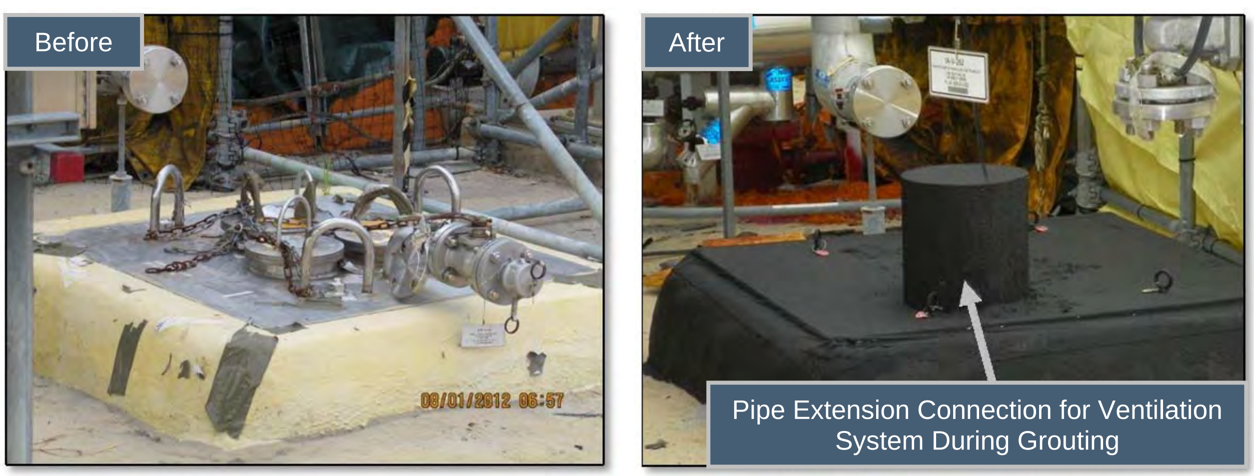
  The practice of adding an additional 35 gallons to each coil after the transition for water to grout was performed as a conservative practice. The additional 15-gallon and 25-gallon grout additions in Tank 5 likely ensured that the water exited these two cooling coils, and they were filled with grout. [SRR-LWE-2013-00214]

- The water in the FTF cooling water system contains chromium for corrosion control. The potential to introduce chromium into Tanks 5 and 6 during cooling coil flushing was identified, and the potential impact was evaluated. The evaluation determined that the maximum potential quantities of chromium that could be flushed into Tanks 5 and 6 (3.81 kg and 3.95 kg, respectively) would not challenge the maximum concentration limit (MCL) for chromium. The actual chromium peak concentration in the 10,000-year performance assessment period for the FTF was only 2.8 µg/L, well below the total chromium MCL of 100 µg/L. Additionally, this peak concentration is driven by the Tank 18 chromium inventory, not the Tanks 5 and 6 chromium inventory. The quantities of chromium potentially flushed from failed cooling coils into Tanks 5 and 6 were below the evaluated limit. [TRC-FTF-2013-00001]

3.2.5 Riser Filling and Capping

For both Tanks 5 and 6, tank top modifications were made to accommodate waste tank riser grouting. Examples of pre-grout modifications included removal of equipment components from risers, and disconnecting and lowering miscellaneous hoses and cables into the waste tank. All waste tank risers were filled with the same type of reducing grout that was used for bulk fill. Figure 3.2-7 shows a typical riser before and after riser filling and capping. The riser cover plate and protruding structures shown in the "Before" photograph were removed prior to grouting and replaced with the riser cover plate shown in the "After" photograph.

Figure 3.2-7: Typical Riser Before and After Filling (Tank 6 Riser 2)



3.2.5.1 Exceptions/Clarifications to Riser Filling and Capping

The Tanks 5 and 6 CM describes capping risers to isolate the risers and structures protruding from the risers. [SRR-CWDA-2012-00071] In fact, there were no structures extending from the risers, so filing the risers to grade level was sufficient.

The primary work packages that implemented grouting of Tanks 5 and 6 may be retrieved from SRS Records Management, if needed. The work packages that addressed grout preparations bulk fill, and riser fill are 01199252-30 and 01199254-18. The work packages that addressed equipment fill preparation and equipment fill are 01199252-46 and 01199254-58. The work packages that addressed cooling coil grouting are 01199252-53 and 01199254-62. Since Tanks 5 and 6 had been isolated from the operating facility, configuration control of waste tank grouting activities was maintained by work packages, consistent with the isolation strategy of each waste tank. [M-CTP-F-00005, M-CTP-F-00006]

3.3 Exceptions/Clarifications to the Tank 6 Floor Inventory

A minor change to the Tank 6 floor inventory recorded in the Tanks 5 and 6 CM was discovered during the closure process. A transcription error resulted in a slightly lower Tank 6 Strontium 90 (Sr-90) inventory being recorded in Table 4.3-5 of the Tanks 5 and 6 CM. The reasonably conservative value (decayed to 2020) of 2.7E+5 curies should have been 2.9E+5 curies. [SRR-CWDA-2012-00075] The lower value was initially used in the Tanks 5 and 6 Special Analysis. [SRR-CWDA-2012-00106] Upon recognition of the error, an evaluation was performed using the corrected inventory. The evaluation showed that the corrected inventory value caused no significant changes to the expected dose results, primarily due to the short (approximately 30 year) half-life of Sr-90. [SRR-CWDA-2013-00110]

4.0 MONITORING

As required by the Tanks 5 and 6 CM, DOE will perform annual inspection and maintenance activities for Tanks 5 and 6 during the interim period between operational closure of Tanks 5 and 6 and the final closure of the FTF operable unit. There are no ancillary structures associated with Tanks 5 and 6 that will be removed from service in the future and require tracking in future waste tank closure modules.

As described in Section 8 of the Tanks 5 and 6 CM, the annual visual inspections of the area surrounding Tanks 5 and 6 will be conducted and documented by procedure/work control processes. Maintenance actions will be performed, as appropriate, to ensure long-term structural integrity of the grouted tanks is maintained and adequately documented. The stormwater system will be maintained to ensure any possible water infiltration through grout is minimized.

After all waste tanks and ancillary structures in the FTF have been removed from service, decisions on removal of external structures such as remaining structural steel trusses, mechanical and electrical piping/conduit, instrumentation and power cables/wiring, raceways, motors, and any other remaining equipment from the tank top footprint will be addressed in conjunction with the final Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act closure of the FTF Operable Unit. [WSRC-OS-94-42]

5.0 CONCLUSION

This FCR is submitted to meet the requirements of the FTF GCP, the Tanks 5 and 6 CM and to satisfy requirements of Section IX of the SRS FFA. [LWO-RIP-2009-00009, SRR-CWDA-2012-00071, WSRC-OS-94-42] This report documents the final configuration of the operationally closed Tanks 5 and 6 in F Area at the SRS and describes field conditions that differ from those described in the Tanks 5 and 6 CM. [SRR-CWDA-2012-00071]

Upon approval of this report and final inspection/walkdown of closure activities by SCDHEC, DOE will request approval to remove these waste tanks from Construction Permit #17,424-IW. An approval letter of the closure activities for these tanks from SCDHEC will represent partial closure of Construction Permit #17,424-IW. [DHEC_01-25-1993]

6.0 PROFESSIONAL ENGINEER CERTIFICATION

The design information in this report was developed from reviews under my direction or supervision, which included drawings, plans, specifications, and associated design documents. I certify that to the best of my knowledge, information and belief, the information represents the current conditions of Tanks 5 and 6 and that each of these waste tanks has sufficient structural integrity to meet the applicable engineering standards.

Stamp

Name: MICHAEL B. WOOD

License Number: 22845

SOUTH CAROLINA PROFESSIONAL ENGINEER LICENSED No. 22845 MICHAEL BRYAN WOOD

7.22.14

SOUTH CAROLINA SAVANNAH RIVER REMEDIATION, LLC No. 3997 CERTIFICATE OF AUTHORIZATION

The construction information in this report was implemented from reviews and inspections under my supervision based upon drawings, plans, specifications and associated design documents. I certify that to the best of my knowledge, information and belief, the field construction/modification information represents the current conditions of Tanks 5 and 6.

Stamp

Name: Andrew R. Redwood

License Number: 20525

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER No.20525 ANDREW R. REDWOOD

7/22/14

SOUTH CAROLINA SAVANNAH RIVER REMEDIATION, LLC No. 3997 CERTIFICATE OF AUTHORIZATION

7.0 REFERENCES

CMD-14-001, Smith, C., *Contract DE-AC09-09SR22505 – Request for Contracting Officer Approval and Direction*, U.S. Department of Energy, Savannah River Site, Aiken, SC, Rev. 0, October 3, 2013.

C-SPP-F-00055, Ganguly, A., *Furnishing and Delivery of Tank Closure Grout*, Savannah River Site, Aiken, SC, Rev. 4, December 19, 2012.

DHEC_01-25-1993, *Construction Permit #17,424-IW for F and H-Area High-Level Radioactive Waste Tank Farms*, South Carolina Department of Health and Environmental Control, Columbia, SC, January 25, 1993.

DHEC_04-25-2013, *SCDHEC Approval for the Savannah River Site Industrial Wastewater Closure Module for the Liquid Waste Tanks 5F and 6F, SRR-CWDA-2012-00071, Revision 1*, South Carolina Department of Health and Environmental Control, Columbia, SC, April 25, 2013.

E-DCP-F-10009, *Tank 5 Electrical Isolation*, Savannah River Site, Aiken, SC, Rev. 0, March 25, 2011. (This document can be made available upon request.)

E-DCP-F-10010, *Tank 6 Electrical Isolation*, Savannah River Site, Aiken, SC, Rev. 0, March 24, 2011. (This document can be made available upon request.)

LWO-RIP-2009-00009, *Industrial Wastewater General Closure Plan for F-Area Waste Tank Systems*, Savannah River Site, Aiken, SC, Rev. 3, January 24, 2011.

M-CTP-F-00005, Campbell, S., *Tank 5F Isolation Strategy*, Savannah River Site, Aiken, SC, Rev. 0, March 9, 2011.

M-CTP-F-00006, Campbell, S., *Tank 6F Isolation Strategy*, Savannah River Site, Aiken, SC, Rev. 1, August 3, 2011.

M-ESR-F-00196, Monaco, P.H., *Federal Facility Agreement Assessment Report for Tank 5 Annulus Level Conductivity Probes and Annulus Steel Wall Thermocouple*, Savannah River Site, Aiken, SC, Rev. 3, December 17, 2012.

M-ESR-F-00197, Monaco, P.H., *Federal Facility Agreement Assessment Report for Tank 6 Annulus Level Conductivity Probes and Annulus Steel Wall Thermocouple*, Savannah River Site, Aiken, SC, Rev. 3, December 17, 2012.

MSDS-34146, *ETGS Invisible Blue*, Ellis Paint Co., Los Angeles, CA, Rev. 0, November 7, 2002.

MSDS-42027, *SC-200*, Spartan Chemical Company, Inc., Maumee, OH, Rev. 1, April 12, 2011.

M-TRT-F-00031, Leonard, R.L., *Tank 5F Closure Mechanical Isolation Matrix*, Savannah River Site, Aiken, SC, Rev. 0, September 20, 2011.

M-TRT-F-00032, Leonard, R.L., *Tank 6F Closure Mechanical Isolation Matrix*, Savannah River Site, Aiken, SC, Rev. 0, September 29, 2011.

SRR-CWDA-2012-00051, *Critical Assumptions in the F-Tank Farm Operational Closure Documentation Regarding Waste Tank Internal Configurations*, Savannah River Site, Aiken, SC, Rev. 0, March 28, 2012.

SRR-CWDA-2012-00071, *Industrial Wastewater Closure Module for the Liquid Waste Tanks 5F and 6F F-Area Tank Farm, Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 1, April 15, 2013.

SRR-CWDA-2012-00075, *Tank 6 Inventory Determination*, Savannah River Site, Aiken, SC, Rev. 1, August 9, 2013.

SRR-CWDA-2012-00106, *Tanks 5 and 6 Special Analysis for the Performance Assessment for the F-Area Tank Farm at the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 1, January 15, 2013.

SRR-CWDA-2013-00110, *UWMQE for New Data Regarding the Tank 6 Sr-90 Inventory Multiplier*, Savannah River Site, Aiken, SC, Rev. 0, August 12, 2013.

SRR-LWE-2012-00087, *Grout Strategy for Tanks 5 and 6 Closure*, Savannah River Site, Aiken, SC, Rev. 3, February 5, 2014.

SRR-LWE-2013-00214, *Engineering Path Forward – Tanks 5 & 6: Record of Additional Grouting* Actions, Savannah River Site, Aiken, SC, Rev. 0, February 18, 2014.

SRR-LWE-2013-00227, *Tanks 5 and 6 Final Configuration Report Inputs,* Savannah River Site, Aiken, SC, Rev. 1, March 19, 2014.

T-CLC-F-00496, *Closure Grouting for Type 1 Tanks 5 and 6,* Savannah River Site, Aiken, SC, Rev. 0, August 2, 2012.

TRC-FTF-2012-00009, *Unreviewed Waste Management Question Evaluation for Incidental Addition of FTGS Invisible Blue (MSDS-34146) into Tanks 5 and 6*, Savannah River Site, Aiken, SC, Rev. 0, July 18, 2012.

TRC-FTF-2012-00013, *Unreviewed Waste Management Question Evaluation for Use of SC-200 (MSDS-42027) on Submersible Mixer Pumps for Contamination Control in Tank 6*, Savannah River Site, Aiken, SC, Rev. 0, July 18, 2012.

TRC-FTF-2013-00001, *Approval of Chromate Cooling Water Entering Tks 5 & 6 During the Process of Flushing Cooling Coils*, Savannah River Site, Aiken, SC, Rev. 0, March 26, 2013.

TRC-FTF-2013-00320, *Grout Compressive Strength Testing*, Savannah River Site, Aiken, SC, Rev. 0, December 17, 2013.

USQ-FTF-2013-00317, *Use-As-Is Disposition of the Non-Conformance Report (NCR) 2013-NCR-15-WFC-0006 "F Tank Farm Grout - Tank 6". Non-Conformance Tank 6 Grout Water Content Higher than Allowed per C-SPP-F-00055, Rev. 4 "Furnishing and Delivery of Tank Closure Grout"*, Savannah River Site, Aiken, SC, Rev. 0, October 28, 2013.

WDPD-14-16, *Completion of Operational Closure of Tanks 5 and 6,* Savannah River Site, Aiken, SC, Rev. 0, December 19, 2013.

Work Package 01199252, *Tank 5 Equipment D&R and Grout Preps,* Savannah River Site, Aiken, SC, includes Tasks 30, 46 and 53, planning date February 2013. (This document can be made available upon request.)

Work Package 01199254, *Tank 5 Equipment D&R and Grout Preps,* Savannah River Site, Aiken, SC, includes Tasks 18 and 62, planning date February 2013. (This document can be made available upon request.)

WSRC-OS-94-42, *Federal Facility Agreement for the Savannah River Site*, as amended, Savannah River Site, Aiken, SC, January 16, 2013.

WSRC-STI-2008-00298, *Closure of HLW Tanks – Phase 2 Full Scale Cooling Coils Grout Fill Demonstrations,* Savannah River Site, Aiken, SC, Rev. 0, June 2008.