Integrated Salt Waste Processing at the Savannah River Site - 17413

Keith D. Harp* and Sonitza M. Blanco**
*Savannah River Remediation, LLC
** United States Department of Energy, Savannah River Office
keith.harp@srs.gov
sonitza.blanco@srs.gov

ABSTRACT

Treatment and disposition of salt waste is the critical path to completion of the Savannah River Site (SRS) Liquid Waste (LW) Disposition and Cleanup Program. The new Salt Waste Processing Facility (SWPF) is a critical link in the pre-treatment chain and will process high-curie salt waste removed from various SRS liquid waste storage tanks. Significant infrastructure modifications are underway throughout the existing LW facilities to integrate the SWPF into the LW system.

INTRODUCTION

The Liquid Waste (LW) System at Savannah River Site (SRS) is a highly integrated operation involving safely storing radioactive liquid waste in underground storage tanks; removing, treating, and dispositioning the low-level waste (LLW) fraction in saltstone or grout; vitrifying the high-level waste; and storing the vitrified waste in stainless-steel canisters on site until permanent disposition is available.

The Salt Waste Processing Facility (SWPF) will remove strontium (Sr), actinides, and cesium (Cs), so the resulting decontaminated salt solution (DSS) can be sent to the Saltstone Facility for disposal as LLW. The concentrated Sr, Cs, and other actinides are sent to the Defense Waste Processing Facility (DWPF) for vitrification.

The LW SWPF Integration team is responsible for execution and implementation of the remaining Operational Activities required to ensure the existing LW facilities are fully integrated with the new SWPF. The remaining LW modifications include:

- H-Tank Farm Blend & Feed Tanks – modifies two existing 3.78 million liter (one million gallon) waste tanks and transfer infrastructure to support SWPF feed staging, blending, and transfer to SWPF
- DWPF – adds new piping, interlocks, valves, and monitoring and control instrumentation to receive the concentrated Cs and Sr/actinides streams from SWPF
- Transfer Lines - provides tie-in of four transfer lines provided by the SWPF Project, transfer line modifications to Saltstone and DWPF facilities, and distributed control system modifications to align the existing LW facilities with SWPF

In addition to the aforementioned scope, the LW Contractor provides Department of Energy (DOE) with Design Authority and Commissioning oversight support as well as coordination of site services to ensure full integration of SWPF with existing LW facilities during SWPF Commissioning, and first year of operation.

BACKGROUND

The mission of the SRS Tank Farms is to receive, store, transfer, and manage high-level radioactive liquid waste generated at SRS. The large underground storage tanks and associated equipment, known as the "tank farms", include a complex interconnected transfer system, which includes underground transfer pipelines and ancillary equipment to direct the flow of waste. The waste in the tanks is present in three forms: supernatant, sludge, and saltcake. The supernatant is an alkaline aqueous mixture, while sludge consists of insoluble solids and entrapped supernatant. The saltcake results from the evaporation (water removal) of the supernatant. The tank waste is retrieved and treated as sludge or salt solution. Saltcake is retrieved from the waste tanks by dissolving the saltcake with water, and finally retrieving the DSS for further processing. The high-level (radioactive) fraction (actinides, Sr, and Cs) of the waste is vitrified into a glass waste form, while the low-level waste is immobilized in cementitious grout waste called saltstone. Once the bulk of the waste is retrieved, heel removed, and chemically cleaned if needed, the tank is operationally closed by stabilizing remaining residuals with tailored grout formulations and sealing external penetrations (e.g., cooling coil piping and tank riser openings).

The actinide removal process (ARP) and the Caustic Side Solvent Extraction (CSSX) Unit process are deployed in the ARP/Modular CSSX Unit (MCU), to process salt waste for permanent disposition. Actinide removal from salt waste is accomplished by contacting the salt solution with monosodium titinate (MST), filtering the resulting slurry, transferring the actinide-laden solids to the DWPF for vitrification, and transferring the clarified salt solution to CSSX for cesium removal.

The SWPF is a newly constructed SRS facility currently being commissioned and on track to commence hot operations in fiscal year 2019, that is designed to utilize the same MST treatment and CSSX technologies to treat salt waste with the resulting waste streams to be disposed of through vitrification at DWPF and by incorporation into grout at the Saltstone Production Facility (SPF). The SWPF salt processing rates will be considerably higher than the current ARP/MCU process leading to acceleration of waste tank closure and completion of the LW Mission. Figure 1 provides an overview of the LW System.

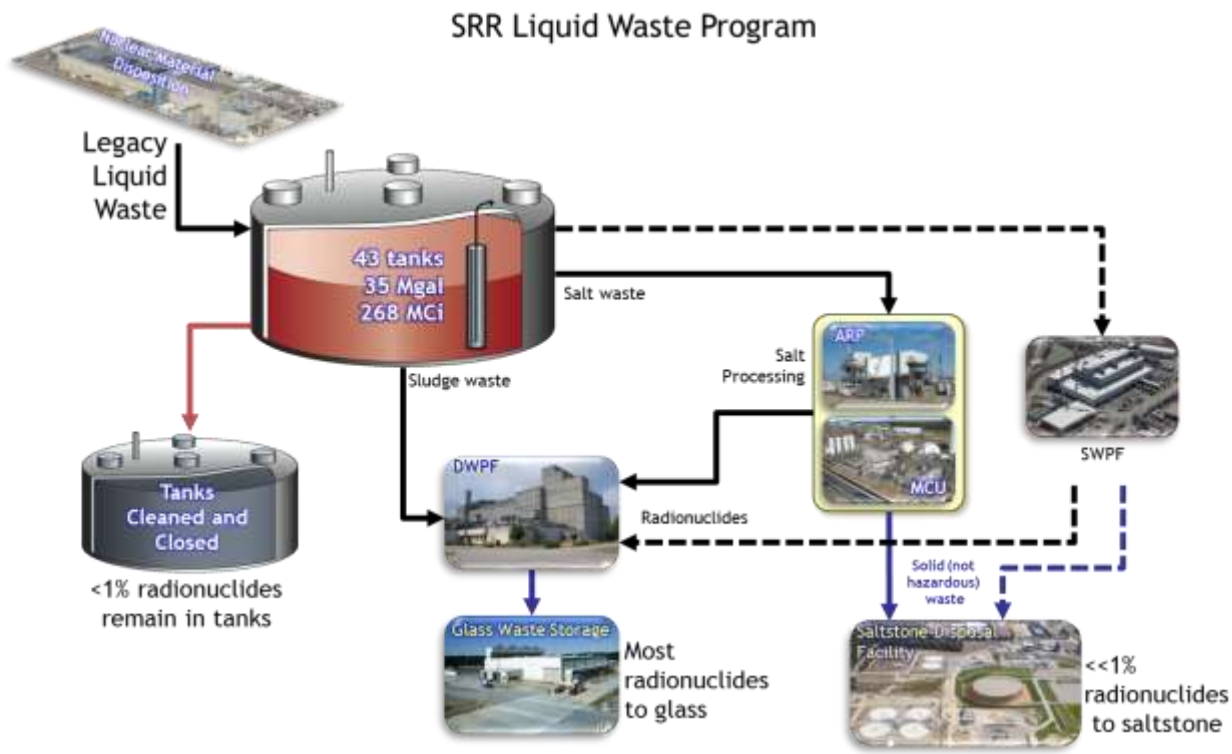

Figure 1. SRS Liquid Waste System Overview

SWPF INTEGRATION SCOPE

The remaining physical modifications are required in the H Area Tank Farm and the DWPF to prepare and stage feed for SWPF and to receive its effluent streams. Additionally, final tie-ins of the Raw Salt Solution (RSS) and DSS transfer lines will be performed upon SWPF receiving Authorization to Operate (ATO) from the DOE.

Integration of modifications within these LW facilities while continuing existing waste processing activities is the key to success.

Blend and Feed Tanks

The SWPF Blend & Feed (B&F) project provides one salt solution Blend Tank (existing Waste Tank 21H), and one SWPF Feed Tank (existing Waste Tank 49H) and the applicable inter-tank transfer lines systems. The blending operation is to blend supernatant liquid into a homogenous mixture to meet the SWPF Waste Acceptance Criteria (WAC). H-Tank Farm Operations will perform batch preparation and qualification for a transfer to SWPF of 17.4 million liters (4.6 million gallons) of salt waste feed material in the first year and step increase up to 34 million liters (9.0 million gallons) per year in subsequent years.

Blending requires the miscible salt solutions from multiple source tanks per SWPF feed batch to be well mixed without disturbing settled sludge solids that may be present in the designated Blend Tank. To develop the necessary technical basis for the design and operation of blending equipment, scaled blending, transfer pump tests, and Computational Fluid Dynamics (CFD) modeling were previously conducted. An eight foot diameter pilot-scale blending tank, including tank internals such as the blending pump, transfer pump, removable cooling coils, and center column were used. Blending tests determined that pump should be angled upward 15º from horizontal and oriented parallel to the tank wall with the discharge located approximately mid-height of the tank level to prevent solids disturbance for a very thin, conservative, sludge simulant. Experimental results were compared to CFD results and available engineering literature to validate CFD modeling. Experimental equipment arrangement is shown in Figure 2.

Figure 2. Submersible Blender Pump – Laboratory 1/10th Scale Testing

New submersible transfer pumps were also designed and procured to allow transfer of blended salt solutions without entraining and transferring forward any settled solids which could challenge allowable solids in SWPF feed.

The Tank 21 modifications include design, construction, and facility support to prepare it to be used as a SWPF Blend Tank. This tank already has operable mixing pumps and minimal settled solids. Therefore, the existing pumps will be used for blending with a subsequent settling period to minimize any suspended solids in the blended salt solution. Due to the expected radioactivity levels in the blended SWPF feed, additional shielding had to be installed around the tank's transfer pump riser.

The Tank 49 modifications include design, construction, startup testing, and facility support to prepare Tank 49H to be the SWPF Feed Tank. Tank 49H currently serves as the feed tank for the existing ARP/MCU process. The existing transfer pump will be replaced with a new submersible transfer pump sized to transfer waste the longer distance to SWPF. The higher discharge pressure from the new transfer pump requires new transfer piping to be installed for portion of the transfer path to SWPF. The existing transfer line into the tank will be modified to provide an incoming blended feed transfer discharge point high in the tank to avoid disturbing any settled solids. See Tank 49H in Figure 3.

Figure 3. Tank 49H – Future Feed Tank for SWPF

DWPF Modifications

The DWPF Modifications scope will modify existing infrastructure and facilities to receive high activity effluent streams from the SWPF. The existing Low Point Pump Pit (LPPP) facility will be a hub for transfers between H-Tank Farm to SWPF and from SWPF to DWPF. As its name implies, the LPPP is physically at the lowest elevation for transfers between SWPF and LW facilities. Transfer piping adjacent to the LPPP will be modified to create connections to LPPP process vessels allowing draining of the transfer piping when needed.

Qualified salt solution feed for SWPF will be transferred from Tank 49H through both existing and new underground transfer piping and will pass through the LPPP Recycle Cell, with drain connection to the Recycle Pump Tank, before being received in SWPF. The Monosodium Titanate (MST)/Sludge stream from SWPF will be received in the LPPP Precipitate Pump Tank (PPT) prior to transfer to DWPF. The Strip Effluent stream from SWPF will pass through the PPT cell, with drain connection to the PPT vessel, prior to being received in the Strip Effluent Feed Tank in DWPF. Due to the new stream transfer paths through the LPPP cells, cell sump pumps, leak detection capability and piping are being added.

Both the MST/Sludge and Strip Effluent streams may contain residual organic extraction solvent from SWPF processing which in turn presents a flammability potential for the LPPP cells and vessels. The DWPF Modifications project scope includes new temperature interlock and instrumentation to monitor the LPPP PPT vessel temperature, and to shut off mechanical heat generation sources (e.g., transfer pump, agitator) upon high temperature. Controls and instrumentation will be provided to stop the LPPP-PPT transfer pump on low agitator power.

East and West Transfer Line Tie-ins

The East and West Transfer Line Tie-Ins projects provide new underground transfer piping connections between new SWPF transfer lines and existing LW piping.

The East Transfer Line tie-in provides a route for transferring DSS from SWPF to Tank 50H in the H Area Tank Farm (HTF). New DSS transfer piping was installed by SWPF in 2013 to a designated tie-in point near the existing H Area to Saltstone Inter Area Transfer Line (IAL). That new piping has been modified by LW to extend it to as close to the IAL as possible. Additionally, as-built design information was obtained from the IAL to ensure the final tie-in would be completed with minimal outage time. The final tie-in "tee" has been designed and fabricated and is stored awaiting DOE direction to proceed with the final tie-in. While this piping connection presents the unique challenge of draining and flushing the IAL prior to making the tie-in, LW is developing a flush and drain plan that will guide the required steps to execute this scope.

Figure 4. Installation of East Transfer Lines

The West Transfer Line tie-ins will initially install sheet-piling adjacent to the LPPP to prevent earthen collapse of the excavation, which will measure approximately 75'L x 48'W x 30'D. This excavation is anticipated to be open for approximately one year to allow the piping modifications, leak testing, and then final backfill to be performed. The required piping modifications will install piping to connect new MST/Sludge, Strip Effluent, and RSS feed piping from SWPF to existing LW piping adjacent to the LPPP. Figure 8 shows installation of the SWPF piping to the designated tie-in point near the LPPP. Installation of the SWPF Project piping was completed in July 2014.

Figure 5. Installation of West Transfer Lines

This project also establishes the LW Distributed Control System modifications to facilitate transfers between H-Tank Farm, SWPF, and DWPF. Both hardware and software modifications will create DCS alarms, interlocks, and permissive signals to enable waste transfers between LW and SWPF. Integrated startup testing, operating procedure development, and operator training will be needed to demonstrate transfer proficiency between affected facilities.

SWPF INTEGRATION OUTAGE AND READINESS MANAGEMENT

To ensure the required LW scope is performed on the as-needed timeframe to support the successful startup and long term operations of the SWPF, the LW contractor has inserted an Outage and Readiness Manager to oversee the schedule and execution of this very important scope.

There are three key outages planned to execute the scopes identified above;

1. The sheet-piling is scheduled to be installed in Q2FY17
2. The LPPP piping and Tank 49 feed tank modifications are scheduled to occur in Q4FY17
3. The SWPF final tie-ins are scheduled to occur in Q1FY19

With performance of each of the outages and accomplishment of the scope execution, Readiness Assessments will be performed in accordance with the DOE Order 425.1D.

SWPF INTEGRATION SUPPORT

In addition to the physical LW infrastructure modifications defined above, SRR provides coordination and integration management services to the SWPF DOE Project Office. Key interfaces for services such as utilities, domestic and fire water supplies, and radioactive and hazardous waste management are defined through Interface Control Documents (ICDs), approved jointly by DOE, the LW contractor and the Engineering, Procurement, and Construction (EPC) contractor for SWPF. ICDs also address technical process interfaces including waste transfer controls and waste acceptance criteria development. A total of 27 ICDs are established.

Identifying key interface activities and managing those activities through a project schedule are essential to minimizing interface issues that could impact SWPF startup. Since 2014, the Integrated Project Team (IPT) with participation from the LW and EPC contractors as well as the DOE has maintained a detailed schedule of the LW and SWPF activities needed to support a successful SWPF startup and long-term operation.

CONCLUSION

The scope to prepare for the startup and operation of SWPF spans many of the existing LW operating facilities. Significant physical infrastructure modifications are needed to create the necessary waste transfer paths and processing capability. The LW SWPF Integration team members will install and test those modifications to ensure LW readiness prior to the SWPF ORR.

Detailed execution schedules are developed for each scope showing completion of the LW SWPF integration scope prior to the projected startup of SWPF. Other interface support is defined and managed through the ICD process utilizing close coordination between DOE and their LW and SWPF contractors. A new IPT focused on integrating SWPF and LW activities as appropriate will provide additional management oversight to key activities and help ensure early identification and resolution of interface issues.

Accelerated salt waste processing is critical to the overall LW mission. Through continued emphasis on efficient project execution and integration management, the LW contractor is on track to support the startup of SWPF.

REFERENCES

1. D.P. Chew and B.A. Hamm, "Liquid Waste System Plan", SRR-LWP-2008-00001, Revision 20, March 2016
2. R.A. Leishear, M.D. Fowley, and M.R. Poirier, "SDI, Blend and Feed Blending Pump Design, Phase 1", Savannah River National Laboratory, SRNL-STI-2010-00054, Revision 0, June 2010.
3. R.A. Leishear, M.D. Fowley, and M.R. Poirier, "Blending Study for SRR Salt Disposition Integration: Tank 50H Scale-Modeling and Computer-Modeling for Blending Pump Design, Phase 2 (U)", Savannah River National Laboratory, SRNL-STI-2010-00151, May 2011.
4. R.A. Leishear, M.R. Poirier, and S.Y. Lee, "Tank 21 and Tank 24 Blend and Feed Study: Blending Times, Settling Times, and Transfers", Savannah River National Laboratory, SRNL-STI-2012-00306, May 2012.
5. R.J. Gray, "Task Requirements and Criteria SDI Blend and Feed Project", M-TC-H-00071, Revision 10, September 6, 2012.
6. R.M. Hoeppel, "Task Requirements and Criteria DWPF Modifications for Salt Disposition Integration", G-TC-S-00003, Revision 3, August 16, 2010.
7. R.J. Gray, "Task Requirements and Criteria Tank 50H Return to Service – East Transfer Line Scope", G-TC-H-00049, Revision 1, April 2, 2009.
8. R.M. Hoeppel, "Task Requirements and Criteria West Transfer Line Modifications for Salt Waste Processing Facility Tie-in to DWPF", G-TC-S-00004, Revision 2, November 8, 2012.
9. "Interface Control Document List", V-ESR-J-00001, Revision 1, May 25, 2010.