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Salt Waste Processing Facility Analytical Laboratory Capability Expansion – 23380

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ABSTRACT

Past production of nuclear material at the Savannah River Site (SRS) has generated legacy liquid radioactive waste that is stored in 43 underground waste storage tanks. The Salt Waste Processing Facility (SWPF) plays a crucial role in the remediation and closure of these waste tanks by treating salt waste from these tanks prior to disposal. Salt waste batches received from these tanks must meet the SWPF Waste Acceptance Criteria. Historically, qualification analyses of batches of the salt waste have been performed by an external laboratory. Additionally, SWPF has encountered circumstances when internal samples were sent to an external laboratory for further characterization in support of troubleshooting process system upsets. The Caustic Side Solvent Extraction (CSSX) solvent used in the process is also sent to an external lab for Extraction Scrub Strip (ESS) testing to evaluate the solvent's performance characteristics. The salt batch qualification samples and unplanned process troubleshooting samples require a prompt turnaround that an outside laboratory may not be able to support, which would negatively affect the ability of SWPF to remain operational. SWPF's Analytical Laboratory incorporates analytical capabilities necessary to ensure SWPF operations meet process control, authorization basis, and product verification requirements. The SWPF Laboratory is in the process of expanding their analytical instrumentation to include the capability to perform the salt batch qualification, sample characterization and ESS testing of the CSSX solvent internally. The analytical instrumentation includes a Total Mercury Analyzer, an X-Ray Diffraction system, and a Fourier Transform Infrared Spectrometer. The ESS testing capabilities will allow SWPF to assess the performance of the CSSX solvent internally. The additional capabilities will also allow for troubleshooting of process samples to include further studies of solids in the process. Expanding the SWPF analytical laboratory capability to include these analyses will reduce the turnaround time on qualification samples, reduce the cost to perform these analyses, and mitigate the risks of unplanned downtime thus supporting the plant's ability to remain operational and the overall goal of SRS to close the underground waste storage tanks.

INTRODUCTION

The Savannah River Site, located in Aiken, SC, was built in the 1950s to support the production of materials used in nuclear weapons during the Cold War. Five reactors and ancillary facilities were built to support production of these nuclear materials. After the Cold War ended, SRS shifted focus to environmental remediation. Legacy liquid radioactive waste generated by past nuclear production is currently stored in underground waste storage tanks in tank farms at SRS. Currently, there are over 130 million liters of radioactive liquid waste stored in 43 underground waste storage tanks. Figure 1 shows the waste tank make up and inventory at SRS. Figure 2 shows the overall SRS liquid waste cycle.

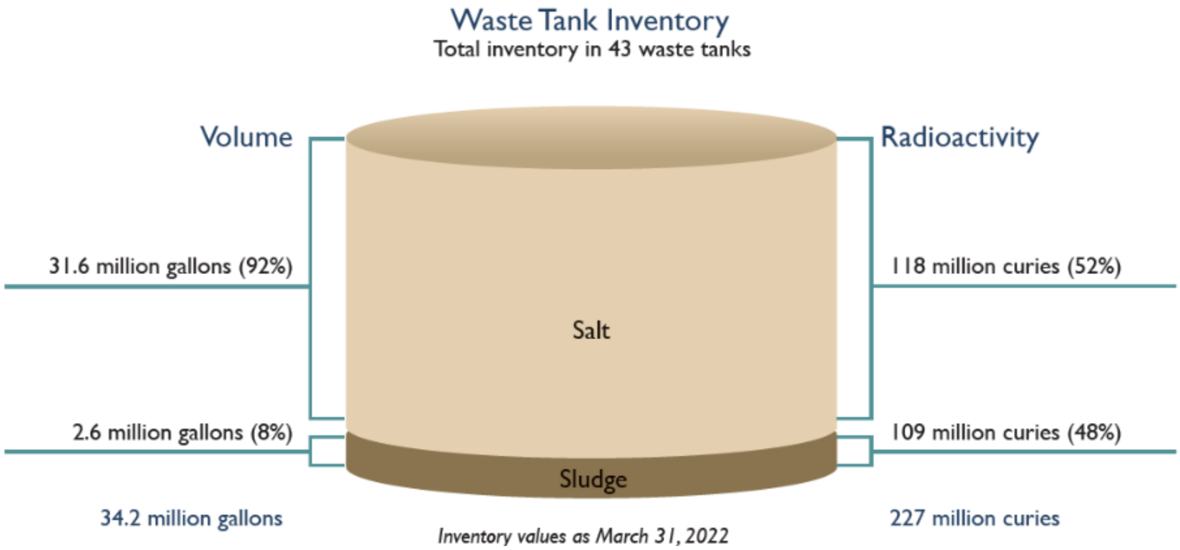

Fig. 1. Waste tank inventory at SRS[a].

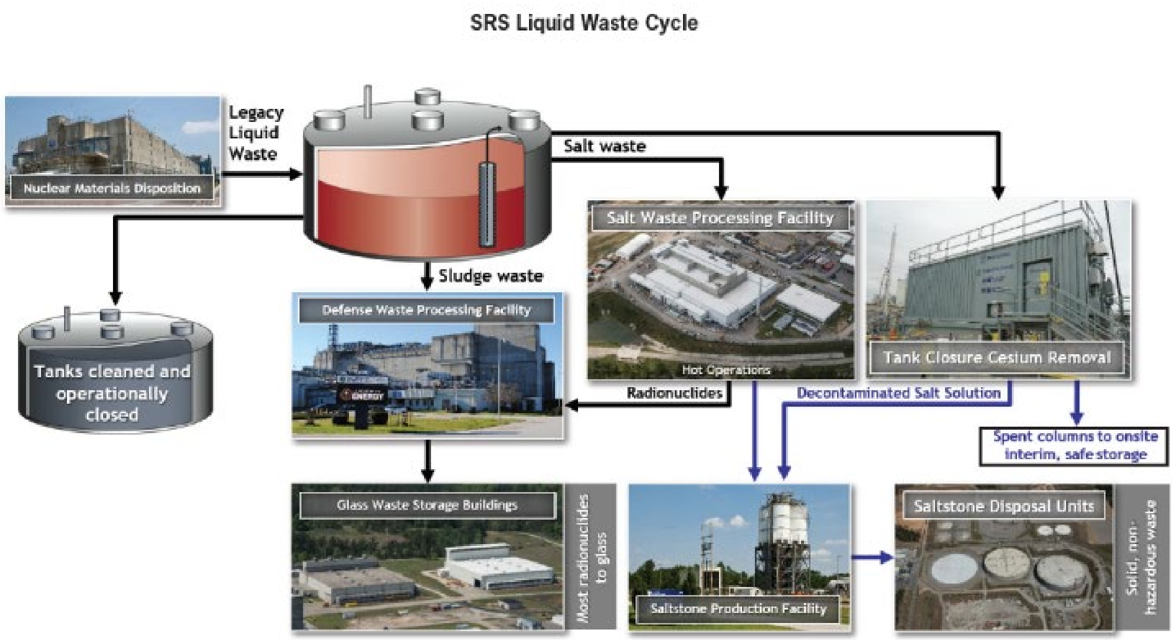

Fig. 2. Liquid waste cycle at SRS[b].

BACKGROUND

The radioactive liquid waste stored in the tanks at the tank farms consists of salt and sludge waste. Both the salt and sludge waste contain highly radioactive residue. The salt waste consists of a solid salt cake and a concentrated salt supernate. The salt supernate contains constituents including soluble radio cesium, soluble metal ions and trace quantities of sludge. The solid salt cake crystallized out of solution and must be re-dissolved by adding water prior to processing. The sludge waste consists of insoluble solids (including radioactive metal oxides). The sludge waste settles to the bottom of the waste tanks. The salt supernate contains most of the soluble cesium and it is treated at SWPF. The salt cake will be re-dissolved with water prior to treatment at SWPF. The sludge waste is treated at the Defense Waste Processing Facility (DWPF).

Through a process called vitrification, DWPF immobilizes low volume high activity liquid radioactive waste and sludge into a stable glass matrix that is subsequently placed in stainless-steel canisters for long-term storage and disposal. The Saltstone Production Facility (SPF) immobilizes high volume low activity liquid radioactive waste by mixing with slag and fly ash to form grout. The grout is pumped into cells where it cures into a stable cementitious material called saltstone. Prior to processing at SWPF the waste is pumped to a blending tank for blending and testing to ensure that the waste stream meets the SWPF Waste Acceptance Criteria (WAC). This testing is called Salt Batch Qualification. After sampling, waste is sent to a staging tank and then to SWPF for treatment. SWPF subsequently separates the waste into a low-volume, high-activity stream for further processing at DWPF and a high-volume, low-activity stream for processing at SPF. Figure 3 illustrates the role that SWPF, DWPF, and SPF play in the SRS liquid waste system.

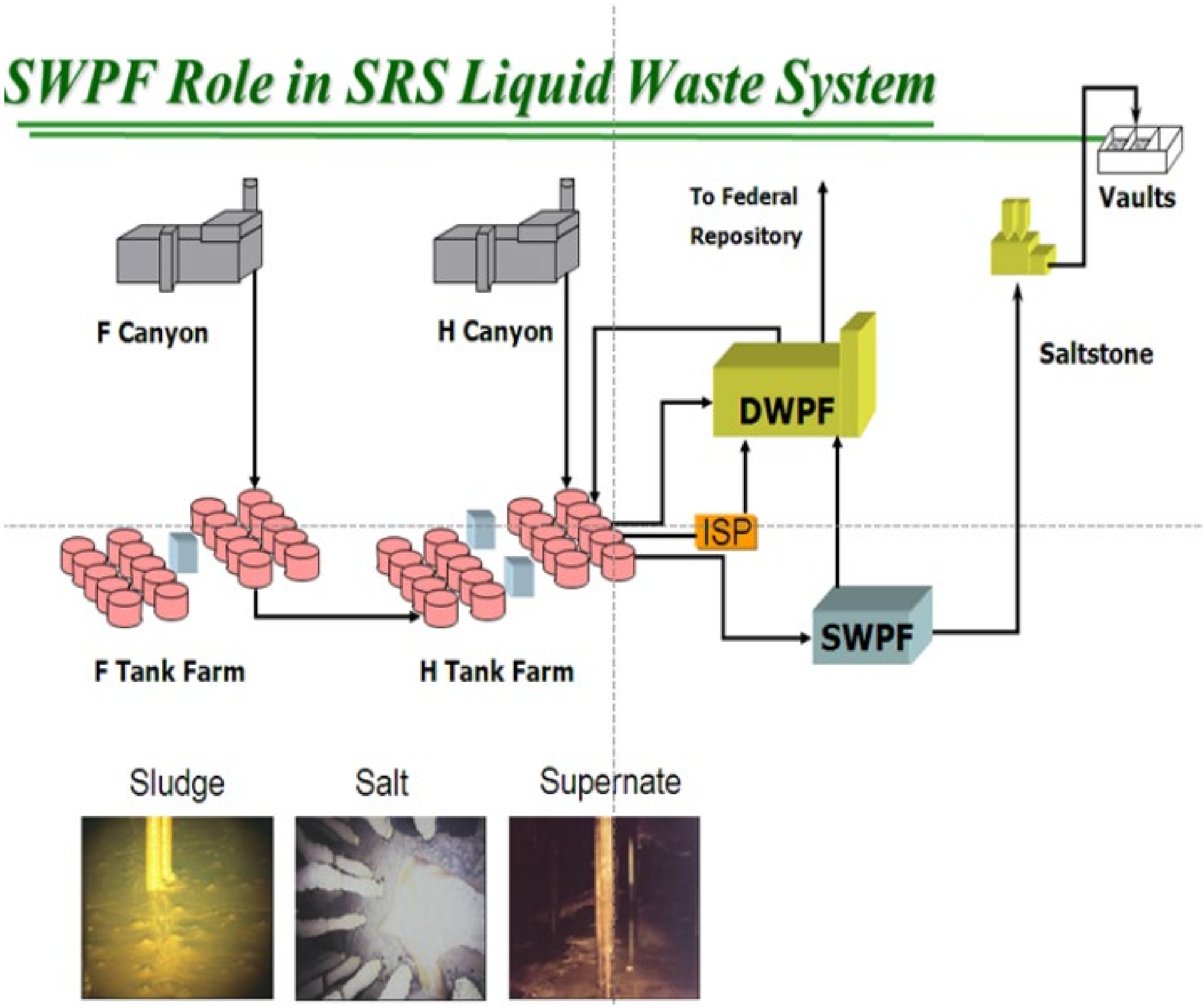

Fig. 3. SWPF plays an integral role in SRS liquid waste system[c].

Occasionally, SWPF has contended with circumstances where process upsets required troubleshooting analyses and characterization. The Caustic Side Solvent Extraction (CSSX) solvent used in the process also requires a qualification via Extraction Scrub Strip (ESS) testing to evaluate the solvent's performance characteristics. Previously the salt batch qualification testing, process upset troubleshooting, and ESS testing have all been performed externally. The salt batch qualification and process upset troubleshooting samples are high priority to SWPF and need an expeditious turnaround time that may not be possible for an external laboratory to support.

DISCUSSION

The SWPF Analytical Laboratory was designed to include the analytical abilities essential to ensuring SWPF operations meet process control, authorization basis, and product verification requirements. The SWPF Laboratory is expanding its analytical instrumentation to support performing the salt batch qualification, sample characterization, and ESS testing of the CSSX solvent internally.

Lab Instrumentation

Table I shows the SWPF analytical laboratory instrumentation and analyses performed via these instruments. The laboratory possesses an Ion Chromatography (IC) system, an Inductively Coupled Plasma Mass Spectrometer (ICP-MS), an Autotitrator for pH analysis, a Turbidity Meter, a Total Inorganic and Total Organic Carbon analyzer (TIC/TOC), a High Purity Germanium (HPGe) Detector, an Alpha Spectrometer, a Liquid Scintillation Counter (LSC), a Gas Chromatograph with Flame Ionization Detector (GC-FID), and a Gas Chromatograph with Mass Selective Detector and a Flame Ionization Detector (GC-MS/FID).

TABLE I. SWPF Analytical Laboratory Instrumentation and Analyses

Instrumentation	Analyses
Ion Chromatography (IC) system	Separate and quantify anions and cations in solution
Inductively Coupled Plasma Mass Spectrometer (ICP-MS)	Trace elemental analysis
Autotitrator for pH analysis	Acid and base titrations and pH measurements
Turbidity Meter	Suspended solid content
Total Inorganic and Total Organic Carbon analyzer (TIC/TOC)	The TIC/TOC measures the total organic and total inorganic carbon content in a sample
High Purity Germanium (HPGe) Detector	Qualitative and quantitative analysis of radionuclides in sample based on gamma emitted during the decay process
Alpha Spectrometer	Qualitative and quantitative analysis of radionuclides in sample based on alpha emitted during the decay process
Liquid Scintillation Counter (LSC)	Analyze the gross alpha activity, gross beta activity and the activity of alpha or beta emitting radionuclides in a sample
Gas Chromatograph with Flame Ionization Detector (GC-FID)	Quantitative analysis of hydrocarbons in a sample
Gas Chromatograph with Mass Selective Detector and a Flame Ionization Detector (GC-MS/FID)	Qualitative and quantitative analysis of volatile organic compounds and hydrocarbons in a sample
Total Mercury Analyzer	Quantitatively determine mercury content in a sample
X-Ray Diffraction (XRD) system	Qualitatively determine the molecular structure of a sample
Fourier Transform Infrared (FTIR) Spectrometer	Qualitatively determine the molecular structure of solids, liquid, or gas samples

Lab Testing

The ESS test looks at the CSSX solvent's ability to remove radio cesium from the salt waste. The extraction portion of the test removes cesium from the salt feed to the CSSX solvent. The scrub portion of the test removes interferences from the solvent. The strip portion of the test back extracts cesium from the solvent to an aqueous solution. The distribution ratios of cesium for each portion of the test are calculated by analyzing the cesium content of each phase. The distribution ratios are compared to the acceptable distribution ratios to determine if the CSSX solvent performance is satisfactory. Developing the ESS testing capability will allow SWPF to evaluate the performance of pristine and in use CSSX solvent internally.

CONCLUSION

SWPF plays a vital role in the remediation and closure of the waste tanks at the tank farms. The analytical capability expansion undertaken by the SWPF laboratory will allow the laboratory to perform salt batch qualification testing, process upset analyses, and ESS tests internally. This expansion will reduce the risk and cost associated with these analyses. Performing these analyses internally will allow SWPF to prioritize its samples and will reduce the turnaround time for the qualification and troubleshooting analyses. This expansion will, in turn, reduce the risk of unexpected plant downtime, thus supporting the plant's ability to process salt waste and support the overall goal of SRS to disposition the salt waste and operationally close the underground waste storage tanks.

Footnotes:

[a] Department of Energy Facts from the Savannah River Site. (n.d.). Liquid Waste Tank Farms. [1]

[b] Department of Energy Facts from the Savannah River Site. [2]

[c] Department of Energy Salt Waste Processing Facility Fact Sheet [3]

REFERENCES

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