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Tank Farm Salt Dissolution Success and Improvements – 23229

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ABSTRACT

The F-Area Tank Farm (FTF) at Savannah River Site (SRS) consists of twenty-two large underground storage tanks (six of which have been closed from radioactive service) that store radioactive aqueous waste and evaporated saltcake. Efforts to dissolve the saltcake and remove the dissolved salt solution are being performed in Tanks 27 and 44.

Both of these waste tanks are built to nearly identical dimensions with a capacity of approximately 4.92 million liters (1.3 million gallons) and are equipped with similar salt dissolution and waste removal equipment. Salt dissolution and waste removal is being performed in an iterative campaign process. The campaign begins with water being added into the waste tank through multiple Low Volume Mixing Jets (LVMJs), dissolving salt while added in quantities between approximately 95,000 liters (25,000 gallons) and 643,500 liters (170,000 gallons). Once added, the water is either recirculated by mechanical means via Submersible Transfer Pump (STP) or the water is allowed time to soak into the saltcake. The dissolved salt solution is then transferred out of the respective waste tank where it is batched for downstream processing in the Salt Waste Processing Facility (SWPF). The transfer of the dissolved salt solution out of the tank signals the end of that respective campaign.

Between Tanks 27 and 44, there have been fifteen completed salt dissolution and waste removal campaigns in the past twelve months. Each salt dissolution campaign typically takes between two and four weeks to be performed with no downstream processing constraints or equipment failure. In these fifteen completed campaigns, Tanks 27 and 44 have supplied approximately 5.62 million liters (1.48 million gallons) of dissolved salt feed to be processed at the SWPF.

Despite mechanical equipment failures and new Flammability Program requirements, the Tanks 27 and 44 Salt Dissolution and Waste Removal Projects have met and exceeded the volume of dissolved salt solution to satisfy the Liquid Waste System Plan demands for feed to the SWPF. Over the fifteen completed campaigns, it has been determined that two key factors have aided salt dissolution efforts: 1) Using the installed Gas Release Mode (GRM) skid controls to perform Interstitial Liquid Removal (ILR) when transferring out the dissolved salt solution at the end of each campaign, and 2) Ensuring a warm as possible internal waste tank temperature within programmatic limits by isolating chromate cooling water to the tank cooling coils. Salt dissolution and waste removal will continue to be performed in this cyclical campaign manner on Tanks 27 and 44 until the elevation of the Bulk Saltcake Layer (BSL) is reduced adequately for the installation of Commercial Submersible Mixer Pumps (CSMPs).

INTRODUCTION

The mission of SRMC is to achieve tank closure through the disposition of SRS liquid waste in a safe, timely, and cost-effective manner. SRS Tank Farms receive, store, transfer, and manage radioactive liquid waste generated at SRS. These waste tanks receive radioactive liquid waste, prevent escape of radionuclides and hazardous chemicals to the environment, prevent exposure of facility workers, maintain the waste in a retrievable form, provide evaporator feed, and provide salt solution feed for SWPF where it is processed into a low activity fraction for disposal as grout at the Saltstone Disposal Units and a high activity fraction for immobilization in vitrified glass at the Defense Waste Processing Facility (DWPF).

Since SRS began operations in early 1950, its uranium and plutonium recovery processes have generated liquid radioactive waste. Currently, approximately 132 million liters (35 million gallons) of radioactive waste is stored in 43 underground tanks in the F and H areas.

Tank 27 (Fig. 1) and Tank 44 (Fig. 2) are both 4.92 million-liter (1.3 million gallon) capacity Type IIIA waste tanks located in FTF and were placed into service nearly five decades ago. The tank primary shells are 25.9 meters (85 feet) in diameter, and 10.1 meters (33 feet) in height constructed from ASTM A516, grade 70 stress relieved steel. Tanks 27 and 44 have permanently mounted cooling coils hung from the tank ceiling and supported on the tank floor. The primary shells are set within a full secondary shell that is 27.4 meters (90 feet) in diameter and 10.1 meters (33 feet) in height (Fig. 3).

Prior to salt dissolution, there were 18,602 liters (4,914 gallons) of sludge present in Tank 27 with 4.50 million liters (1.19 million gallons) of saltcake on top of the sludge layer. There are no leak sites observed for Tank 27.

Prior to salt dissolution, there 4.54 million liters (1.20 million gallons) of saltcake and no sludge present in Tank 44. There are no leak sites observed for Tank 44.

Fig. *1*. Tank 27 Aerial.

Fig. 2. Tank 44 Aerial.

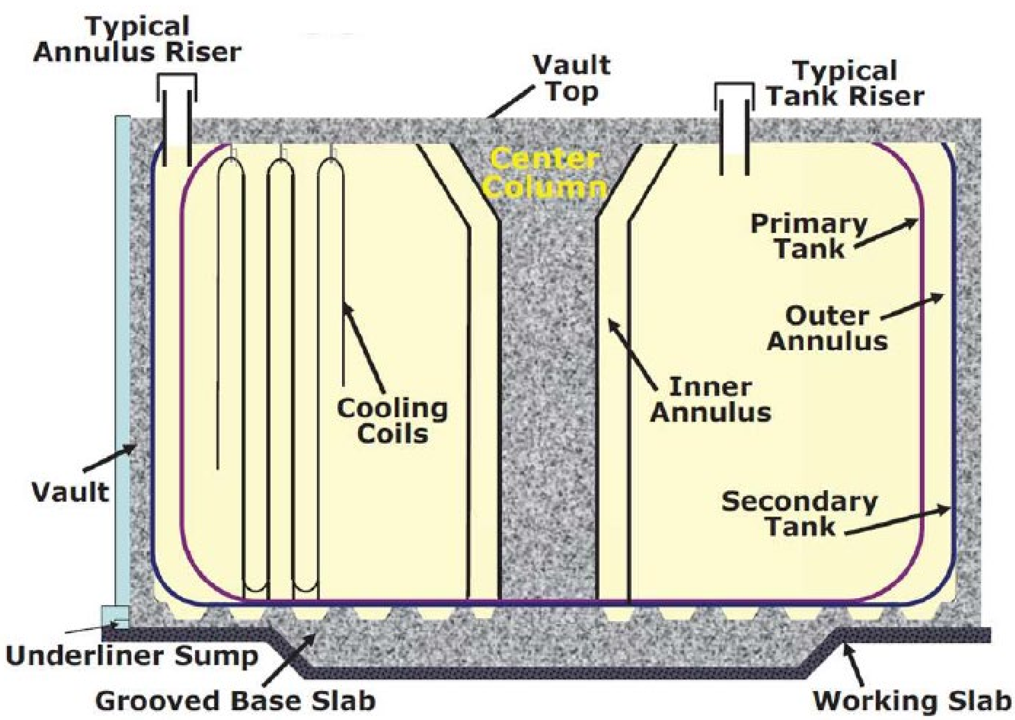

Fig. 3. Typical Type IIIA Tank Diagram.

DESCRIPTION OF METHODOLOGY

The primary objective for both waste tank projects is to provide Dissolved Salt Solution (DSS) feed at a concentration to SWPF that supports system planning goals. CSMPs are predicted to be the most effective method of salt dissolution available for use in the Tank Farms Documented Safety Analysis (DSA) in terms of both salt dissolution time duration and salt dissolution ratio (volume of dissolution water added to saltcake vs volume of salt dissolved). The ideal state would be to install CSMPs at the beginning of each salt dissolution project. Due to the starting BSL elevations typical in the Tank Farms being near the upper fill limits of the waste tanks, initial installation and operation of CSMPs is not feasible in most salt tanks.

CSMPs are mixing pumps with 171.51-kilowatt (230 horsepower) motors with a rated flow of 0.12 cubic meters per second (1950 gallons per minute) with two 0.051-meter (2-inch) diameter tangentially opposing nozzles. While the CSMPs have been operated at reduced speeds and reduced liquid coverage, the manufacturer recommends a minimum submergence level of 1.98 meters (77.9 inches) under normal operation. Tanks 27 and 44 both have high operating limits of 9.14 meters (360 inches) and starting BSL elevations around 8.66 meters (341 inches). To operate the CSMPs at full speed, the BSL would need to be below 7.11 meters (280 inches) at the very least. To compound the issue, the CSMP masts that support the CSMP in the waste tank can only be adjusted in 0.25-meter (10-inch) increments with a maximum travel of 5.08 meters (200 inches). If the CSMPs were installed at an initial elevation of 7.11 meters (280 inches), the assemblies would not be able to be positioned near the bottom of the waste tank as the bottom travel position of the CSMP assembly would be at 2.03 meters (80 inches) from the bottom of the waste tank. This would result in additional CSMP assemblies to be purchased/fabricated and installed to help with dissolution of the entire saltcake volume.

The following strategy of salt dissolution has been implemented on Tanks 27 and 44. This methodology utilizes LVMJs that can be used at initial BSL elevations close to the high tank operating limit of 9.14 meters (360 inches). Due to the BSL elevation and limited vapor space in the waste tank, flammability concerns with dissolving the saltcake warrant the use of GRM modifications/controls. While challenges have occurred during salt dissolution, the following strategy has been successful and will be continued until a BSL of less than approximately 5.08 meters (200 inches) is achieved, to support the installation of CSMP assemblies that can reach the bottom of the waste tanks.

The strategy to perform salt dissolution/waste removal for current and near-future salt tanks, is to install GRM modifications, with the intention of performing salt dissolution/ waste removal in GRM. The intent of installing GRM modifications and performing salt dissolution/waste removal in GRM is to relieve operational limitations from DSA programs, such as the Flammability Program and Gas Release Program. Salt dissolution activities are known to generate/release hydrogen gas into a waste tank vapor space. These activities include ILR, water addition to waste tanks for the purpose of salt dissolution, performing STP recirculation in waste tanks, and running mixing pumps (CSMPs) in the waste tanks. If enough hydrogen gas is generated/released into the waste tank vapor space during salt dissolution activities, the waste tank vapor space could reach a hydrogen concentration that would support a waste tank deflagration. The DSA defines this limit as the Lower Flammability Limit (LFL). The value is 4 volume% concentration of hydrogen gas. Both the Flammability and Gas Release DSA Programs specify controls required to prevent waste tank vapor spaces from reaching LFL. A GRM evaluation is a calculation required for any waste tank intending to perform salt dissolution. This evaluation specifies tank-specific controls in support of the Flammability and Gas Release Programs to prevent the vapor space of a waste tank from reaching LFL during the performance of a gas release activity.

Both Tanks 27 and 44 have installed GRM controls, installed on a GRM skid, located on each respective waste tank top. The Tank 27 equipment arrangement, and specifically the location of the Tank 27 GRM skid, can be seen in Figure 4, below. The Tank 44 equipment configuration is similar in scope but varies in riser placement due to differing configurations of the waste tank risers. Two redundant Flow Indicating Transmitters (FIT)s are connected to a pitot tube style flow element on the discharge piping of the waste tank vapor space purge exhaust ventilation system. If the purge exhaust ventilation flow falls below a defined value as read by either of the FITs, the GRM interlocks activate, closing pneumatic, redundant water addition isolation valves on the GRM skid close to stop waste tank water additions, and redundant STP contactors on the GRM skid open to de-energize the STP, stopping any ILR transfer or STP recirculation activity. A hydrogen monitor installed on the tank top of each respective waste tank actively pulls a waste tank vapor space sample via a tubing system routed to the hydrogen monitor through a riser plug penetration. If the hydrogen concentration read by the hydrogen monitor exceeds a defined value, one of the water addition isolation valves on the GRM skid closes to stop waste tank water additions, and one of the STP contactors on the GRM skid opens to de-energize the STP, stopping any ILR transfer or STP recirculation activity. If the tank purge exhaust ventilation system falls below a defined flowrate or if the waste tank vapor space hydrogen concentration exceeds a defined %LFL, the GRM interlocks activate, stopping waste tank water additions, waste tank STP recirculation, and ILR transfers. Utilizing GRM controls during LVMJ water additions allow larger batch volume additions to be performed. Utilizing GRM controls during ILR transfers allows for the performance of and faster transfer flowrates during ILR in more restrictive tank settings (i.e., higher bulk saltcake elevations and smaller waste tank vapor space volumes).

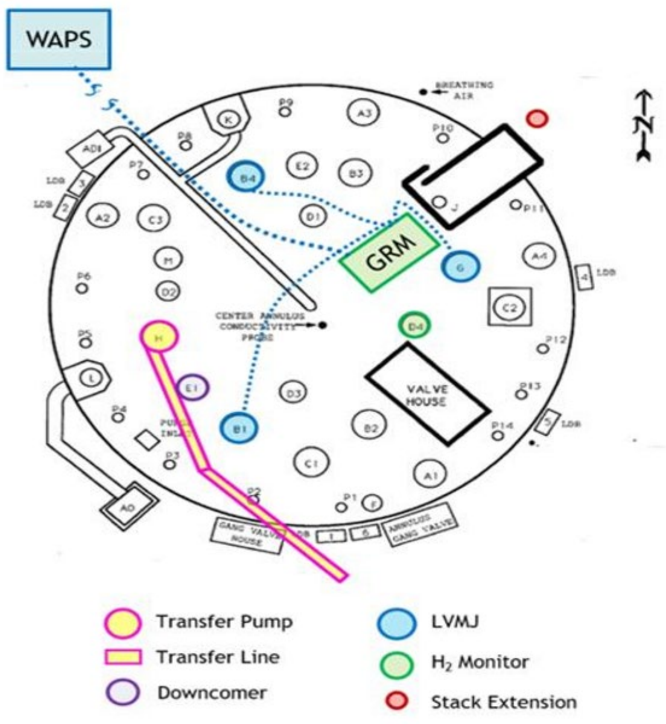

Fig. 4. Tank 27 Equipment Configuration.

Three LVMJs were installed in three separate risers on both Tanks 27 and 44. Figure 4 above shows the roughly triangular installation pattern of the LVMJs to provide maximum coverage possible in Tank 27. The LVMJs in Tank 44 are installed in a similar pattern. During salt dissolution via waste tank liquid addition in both Tanks 27 and 44, Domestic Water (DW) supplied from the Water Addition Pump Skid (WAPS) is routed through the GRM skid control valves, through LVMJs, and into the waste tank. This DW flow path, typical to Tanks 27 and 44 can be seen as the blue dotted line above in Figure 4. The LVMJs are intended to be positioned with the eductor discharge at an elevation near the BSL. The LVMJ eductors discharge parallel to the saltcake surface. As the water is added through the eductor, supernate is entrained creating a sub-saturated plume [2.4 m (8 feet) plume length for a 9.5 mm (3/8 in) eductor with

138 kPa (20 psi) supply pressure] that is distributed across the saltcake surface.

After water additions are completed, the waste tank is given time to soak and allow salt dissolution to occur. The soak times in Tanks 27 and 44 have ranged from four days up to a few months due to programmatic sampling requirements, downstream receipt tank constraints, and equipment failures. Based on samples pulled in the 15 salt dissolution campaigns on Tanks 27 and 44, sufficient saturation of the dissolution DW with dissolved salt has occurred within 7 days. To aid in the salt dissolution process and to provide a more homogenous dissolved salt solution, the Tank 27 project performed STP recirculation during the soak time. During STP recirculation, liquid near the bottom of Tank 27 at pump suction is lifted to the valve manifold approximately 10.7 meters (420 inches) above the tank floor at a rate of approximately 68.1 liters/minute (18 gallons/minute), where a 0.013 meters (0.5 inch) diameter recirculation line deposits the liquid back into the waste tank vapor space on top of the dissolved salt solution.

After the soak/recirculation is performed in Tanks 27 and 44, DSS is transferred out via STP to the downstream receipt tank. Tank 26 is the main DSS receipt tank in FTF for both Tanks 27 and 44. Removal of the DSS is classified in two separate activities: 1) Free Supernate Removal (FSR) and 2) ILR. FSR is a transfer of DSS where the liquid removed is from above the BSL. The position of the pump suction either above or below the BSL is not relevant. As every salt dissolution water addition made in the fifteen performed salt dissolution campaigns on Tanks 27 and 44 has resulted in liquid coverage of the BSL, FSR has been performed first in each salt dissolution campaign. Once enough DSS is removed to uncover the BSL, FSR is declared complete. It is then desired to perform ILR, which will remove liquid below the BSL. Saltcake contains 15% by volume interstitial liquid that is potentially removable through ILR. By performing ILR following FSR for each campaign, a maximum amount of saltcake is exposed, thereby maximizing the amount of saltcake that is available for fresh contact with the dissolution DW to be added in the subsequent campaign. Due to constraints in the Flammability and Gas Release Programs from the DSA, it is common that ILR cannot be performed early in waste tank salt dissolution efforts. ILR can be performed when the BSL is reduced, tank chemistry is within programmatic limits, and additional vapor space is created.

Once the DSS is removed to the maximum extent possible, that salt dissolution campaign is ended, and a new campaign is initiated with the next water addition through the LVMJs. Depending on the BSL elevation resulting from the prior campaign, LVMJs may or may not be lowered to an elevation closer to the BSL, for enhanced salt dissolution efficiency.

Repeating this process provides DSS feed required by SWPF and also reduces the BSL in Tanks 27 and 44. This salt dissolution methodology is intended to be repeated until a BSL less than 5.08 meters (200 inches) is reached in Tanks 27 and 44 to support the installation of CSMPs.

DESCRIPTION AND DISCUSSION OF RESULTS

Tank 27

Approximately 4.09 million liters (1.08 million gallons) of dissolved salt solution has been removed from Tank 27 in the past fifteen months. The BSL has been reduced by 3.45 meters (136 inches) from a maximum of 8.97 meters (353 inches) to the current 5.51 meters (217 inches). This has been accomplished through the completion of eleven salt dissolution campaigns. The volume totals and BSL changes in each salt dissolution campaign can be seen below.

TABLE *I*. Tank 27 Salt Dissolution Results

Campaign	Water Addition Volume		Transfer Volume		End of Campaign BSL		Campaign Duration	STP Recirculation Duration	LVMJ Discharge Elevation	
	LITERS	*GALLONS*	*LITERS*	*GALLONS*	*METERS*	*INCHES*	*DAYS*	*DAYS*	*METERS*	*INCHES*
0 FSR	-	-	58,462	15,444	8.66	341	-	-	Riser B4: 9.40 Riser B1: 9.40 Riser G: 9.40	Riser B4: 370 Riser B1: 370 Riser G: 370
1 FSR	61,827	16,333	85,433	22,569	8.97	353	7.0	3.5	Riser B4: 9.40 Riser B1: 9.40 Riser G: 9.40	Riser B4: 370 Riser B1: 370 Riser G: 370
2 FSR	92,285	24,379	161,966	42,787	8.79	346	153.0	4.0	Riser B4: 9.40 Riser B1: 9.40 Riser G: 9.40	Riser B4: 370 Riser B1: 370 Riser G: 370
3 FSR	123,011	32,496	194,918	51,492	8.59	338	9.0	3.0	Riser B4: 9.40 Riser B1: 9.40 Riser G: 9.40	Riser B4: 370 Riser B1: 370 Riser G: 370
4 FSR	123,264	32,563	182,294	48,157	8.48	334	24.0	4.2	Riser B4: 9.40 Riser B1: 9.40 Riser G: 9.40	Riser B4: 370 Riser B1: 370 Riser G: 370
5 FSR	157,973	41,732	194,252	51,316	8.33	328	23.0	4.0	Riser B4: 9.40 Riser B1: 9.40 Riser G: 9.40	Riser B4: 370 Riser B1: 370 Riser G: 370
6 FSR	161,558	42,679	226,670	59,880	8.18	322	24.0	2.8	Riser B4: 8.51 Riser B1: 8.51 Riser G: 8.51	Riser B4: 335 Riser B1: 335 Riser G: 335
7 FSR	155,796	41,157	173,523	45,840	8.10	319	11.0	3.5	Riser B4: 8.51 Riser B1: 8.51 Riser G: 8.51	Riser B4: 335 Riser B1: 335 Riser G: 335
8 FSR	124,358	32,852	122,905	32,468	8.10	319	13.0	4.0	Riser B4: 7.90 Riser B1: 7.90 Riser G: 7.90	Riser B4: 311 Riser B1: 311 Riser G: 311
9 FSR	124,173	32,803	114,796	30,326	8.10	319	15.0	4.2	Riser B4: 7.90 Riser B1: 7.90 Riser G: 7.90	Riser B4: 311 Riser B1: 311 Riser G: 311
9 ILR	-	-	358,607	94,734	8.10	319	11.0	-	Riser B4: 7.90 Riser B1: 7.90 Riser G: 7.90	Riser B4: 311 Riser B1: 311 Riser G: 311
10 FSR	477,344	126,101	553,794	146,297	7.09	279	35.0	3.8	Riser B4: 7.90 Riser B1: 7.90 Riser G: 7.90	Riser B4: 311 Riser B1: 311 Riser G: 311
10 ILR	-	-	559,105	147,700	7.09	279	22.0	-	Riser B4: 7.90 Riser B1: 7.90 Riser G: 7.90	Riser B4: 311 Riser B1: 311 Riser G: 311
11 FSR	654,914	173,010	753,093	198,946	5.51	217	77.0	4.0	Riser B4: 6.38 Riser B1: 6.68 Riser G: 6.68	Riser B4: 251 Riser B1: 263 Riser G: 263
11 ILR	-	-	371,633	98,175	5.51	217	10.0	-	Riser B4: 5.16 Riser B1: 5.46 Riser G: 5.46	Riser B4: 203 Riser B1: 215 Riser G: 215
Totals	**2,256,503**	**596,105**	**4,111,453**	**1,086,131**	**BSL Change: 3.15**	**BSL Change: 124**	**434.0**	**41.0**	-	-

IIThe first operational step was to remove the liquid present from previous tank liquid additions from the top of the saltcake via a FSR transfer. The transfer started at a liquid level of approximately 9.12 meters (359 inches) and was anticipated to go down to the established BSL of 8.66 meters (341 inches). The transfer flowrate upon transfer initiation was approximately 61 liters per minute (16 gallons per minute) at a pump speed of 2100 Revolutions Per Minute (RPM) with a Specific Gravity (SpG) reading of 1.35. On the morning of 5-23-21, the flowrate had dropped to approximately 15 liters per minute (4 gallons per minute) as indicated by the transfer material balance and the density dip tubes were reading a SpG of 1.43. A camera inspection showed fairly uniform salt mounding on all of the cooling coils in Tank 27 (see Figure 5 below). The transfer was terminated to evaluate the potential for a new BSL elevation and to protect the structural integrity of the cooling coils. After evaluation, the BSL was updated to 8.97 meters (353 inches).

Fig. 5. Exposed Solids in Tank 27.

Per the Tank 27 GRM evaluation (Reference 1), Tank 27 salt dissolution activities are required to be performed with an upper temperature limit for the DSS of 60 degrees C. Leading up to the first FSR transfer where solids were exposed above where expected, several cooling coils had been operational (actively cooling Tank 27) over the previous few months to maintain Tank 27 under the operational limit of 60 degrees C and to reduce tank swelling which commonly occurs in summer months. As shown in Figure 6 below, the Tank 27 waste temperature had remained at approximately 27 degrees C for at least six months leading up to the Campaign 0 FSR transfer in May 2021. Based on previous operational experience, it is assumed that a main contributor of BSL buildup on the cooling coils in Tank 27 was that the cooling coils were operational and actively cooling the tank. Per Reference 2, the solubility of sodium nitrate ($NaNO_3$; which is the primary constituent of saltcake in the Tank Farm waste tanks) increases as temperature increases. In other words, a higher waste tank temperature should allow for improved dissolution of salt mounds in Tank 27.

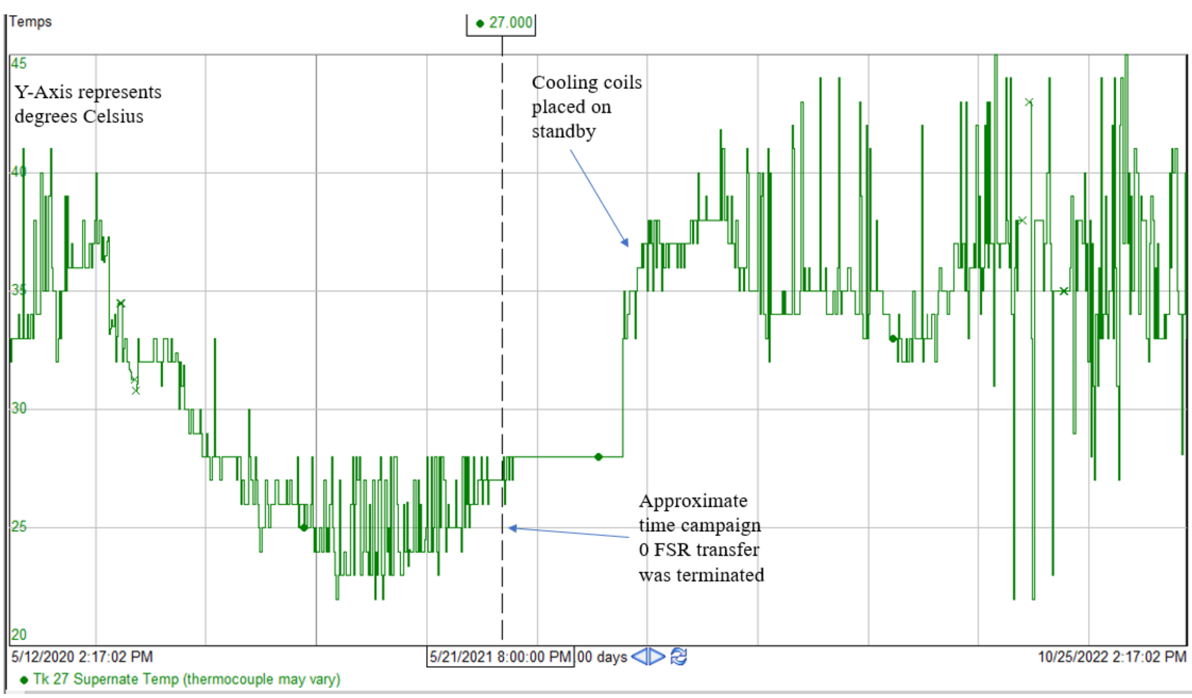

Fig. 6. Tank 27 DSS Temperature Plot.

Operations placed the cooling coils on standby (isolating chromate cooling water flow), which resulted in a rise of tank temperature. Since the cooling coils were placed on standby after Campaign 0 FSR, there have been no signs of salt precipitation due to the internal tank temperature of Tank 27.

Two weeks after the termination of the Campaign 0 FSR transfer in Tank 27, a Variable Depth Sample (VDS) was pulled from Tank 9 in H Tank Farm. Savannah River National Laboratory (SRNL) noted the sample had a higher-than-expected opacity and contained insoluble solids that appeared to have "sludge-like" characteristics. Like Tank 27, Tank 9 is a salt tank, and sludge-like solids were not expected to be present in the salt matrix. SRNL evaluated the VDS from Tank 9 and their findings were accepted by SRMC. The Technical Error Notification process (SRS Manual E7 Procedure 2.33) was initiated to evaluate the impact that the Tank 9 insoluble solids might have on other salt tanks. As a result of this error notification process, a document was generated by SRNL with the conclusion that a conservative 16% by volume of insoluble solids to dissolved saltcake is expected to be generated during waste tank salt dissolution activities (Reference 3). The DSA requires these insoluble solids to be treated like sludge. The Sludge Carryover Minimization (SCOM) Program Description Document (PDD), Flammability PDD, and Transfer Control PDD were revised in response to the SRNL input. These PDD revisions drove revisions to the Tanks 9, 27, and 44 GRM evaluations. Salt dissolution in Tanks 9, 27, and 44 was put on hold while this Error Notification process was executed. Once the GRM evaluations were approved and necessary controls were updated in respective operating procedures, salt dissolution was able to resume. Due to the potential for insoluble solids being precipitated out during salt dissolution in Tank 27, and the updated BSL and restrictions in the Tank 27 GRM Evaluation (Reference 1), the planned activity of performing ILR in Tank 27 could not be completed after Campaign 0 FSR transfer.

Campaigns one through eight of salt dissolution were executed without the ability to perform an ILR transfer. This limited fresh contact of the DW dissolution media with exposed saltcake, hindering the efficiency of salt dissolution. Over the course of the first eight campaigns, 1.00 million liters (264,000 gallons) of DW was added to Tank 27 and 1.40 million liters (370,000 gallons) of dissolved salt solution was transferred out via FSR transfers. Through these campaigns, the BSL was only reduced by 0.86 meters (34 inches) to an elevation of 8.10 meters (319 inches).

Upon finishing the FSR transfer of Campaign nine, the waste tank chemistry, BSL elevation, and insoluble solids accumulation were all within bounds to be able to perform ILR for the first time on Tank 27. Over the course of the next three campaigns (Campaigns nine through eleven), 1.26 million liters (332,000 gallons) of DW was added to Tank 27 and 2.72 million liters (718,000) gallons of dissolved salt solution was transferred out via combined FSR and ILR transfers. Through these campaigns, the BSL was reduced by 2.59 meters (102 inches) to an elevation of 5.51 meters (217 inches).

Tank 44

Approximately 1.53 million liters (404,000 gallons) of dissolved salt solution has been removed from Tank 44 in the past eleven months. The BSL has been reduced by 1.45 meters (57 inches) from a maximum of 8.66 meters (341 inches) to the current 7.21 meters (284 inches). This has been accomplished through the completion of four salt dissolution campaigns. The volume totals and BSL changes in each salt dissolution campaign can be seen below.

TABLE *III*. Tank 44 Salt Dissolution Results

Campaign	Water Addition Volume		Transfer Volume		End of Campaign BSL		LVMJ Discharge Elevation		Campaign Duration
	LITERS	*GALLONS*	*LITERS*	*GALLONS*	*METERS*	*INCHES*	*METERS*	*INCHES*	*DAYS*
0 FSR	-	-	120,864	31,929	8.66	341	Riser B2: 8.74 Riser B4: 8.74 Riser B5: 8.56	Riser B2: 344 Riser B4: 344 Riser B5: 337	-
0 ILR	-	-	136,055	35,942	8.59	338	Riser B2: 8.74 Riser B4: 8.74 Riser B5: 8.56	Riser B2: 344 Riser B4: 344 Riser B5: 337	-
1 FSR	221,098	58,408	258,029	68,164	8.26	325	Riser B2: 8.74 Riser B4: 8.74 Riser B5: 8.56	Riser B2: 344 Riser B4: 344 Riser B5: 337	21.00
2 FSR	94,132	24,867	598,572	158,126	7.42	292	Riser B2: 8.26 Riser B4: 8.26 Riser B5: 8.26	Riser B2: 325 Riser B4: 325 Riser B5: 325	55.00
3 FSR	188,389	49,767	263,188	69,527	7.21	284	Riser B2: 7.34 Riser B4: 7.34 Riser B5: 7.34	Riser B2: 289 Riser B4: 289 Riser B5: 289	10.00
4 FSR	188,264	49,734	153,994	40,681	7.21	284	Riser B2: 7.19 Riser B4: 7.19 Riser B5: 7.04	Riser B2: 283 Riser B4: 283 Riser B5: 277	10.00
Totals	**691,882**	**182,776**	**1,530,703**	**404,369**	**BSL Change: 1.45**	**BSL Change: 57.0**	-	-	**96.00**

IVIn contrast to Tank 27, an ILR transfer was able to be performed immediately after Campaign 0 FSR was completed in Tank 44. Due to Flammability and Gas Release Program restrictions, only a partial ILR was able to be performed. 136,000 liters (36,000 gallons) of the removable 655,000 liters (173,000 gallons) interstitial liquid present, or about 21%, was removed with the ILR transfer. This initial ILR provided efficient salt dissolution for the first couple campaigns. While the Tank 44 salt dissolution team desired to perform ILR each campaign, the tank chemistry did not support further ILR efforts after the Campaign 0 ILR transfer. When ILR is performed, the chemistry of the tank is "reset" and until proven otherwise is assumed bounding (worst case scenario) for the %LFL calculations performed in the GRM evaluation. Through waste tank sampling, the actual chemistry can be determined. Sampling determined that the main variable, Hmix (a variable representing trapped gas content of a saltcake volume), was too high for further ILR transfers. The BSL will have to be lowered to support ILR with the current tank chemistry.

During the Campaign 4 FSR transfer, the Tank 44 STP was interlocked off from the Variable Frequency Drive (VFD) due to an F12 (Overcurrent) fault. A failed bridge test determined that a 30% phase imbalance was present. Due to the remote nature of the STP being installed at the bottom of the waste tank filled with high hazard, radioactive material, repair of the STP is not possible. Replacement efforts are being planned in order to continue salt dissolution on Tank 44. In an effort to hasten replacement efforts for Tank 44 and for future waste tanks with installed STPs, a re-design effort of the STP assembly is being performed by several organizations to facilitate faster STP replacement times in the event of failures. Enhanced quality checks and functional tests are being specified in the fabrication and installation of new STPs. Alternatively, several organizations are exploring alternative STP make/models to improve longevity in the high hazard environment of waste tanks.

CONCLUSIONS

Despite STP equipment failures, new flammability restrictions due to the potential for insoluble solids, and unexpected precipitation of additional saltcake due to cooling coil effects, the Tanks 27 and 44 projects have managed to efficiently dissolve and remove enough DSS to exceed the required SWPF feed in compliance with the SRMC Liquid Waste System Plan. It was anticipated that the BSL in Tank 27 would not be reduced enough to support installation of CSMPs until late calendar year 2023. Due to the eleven successful salt dissolution campaigns performed in Tank 27, the BSL is now anticipated to be at an elevation that supports the installation of CSMPs in Risers B2 and B4 by the end of calendar year 2022. As a result of the increased dissolved salt solution needs to support SWPF batches, and the limited salt dissolution campaigns in recent years, there was concern that salt dissolution efforts would not be able to successfully produce the quality of DSS that the system plan anticipated would be needed. As a result of the successful salt dissolution campaigns in Tanks 27 and 44, all available receipt tanks for DSS are full, and volume relief as a result of SWPF salt batch preparation and qualification is not anticipated until mid-to-late calendar year 2023.

As discussed above and as shown below in both Figures 7 and 8, the performance of ILR to remove as much DSS possible at the end of each campaign has been the main factor of success for both Tanks 27 and 44. The relatively shallow slope of the BSL progression lines in the below figures when no ILR is performed highlights this point. While the performance of ILR has been limited by programmatic constraints, it would never be possible at the present BSL elevations, if not for the use of the GRM controls. The GRM controls provide operational flexibility to perform ILR at the restrictive tank conditions (such as high initial BSL elevations) in a manner that is in line with the Flammability and Gas Release DSA Programs.

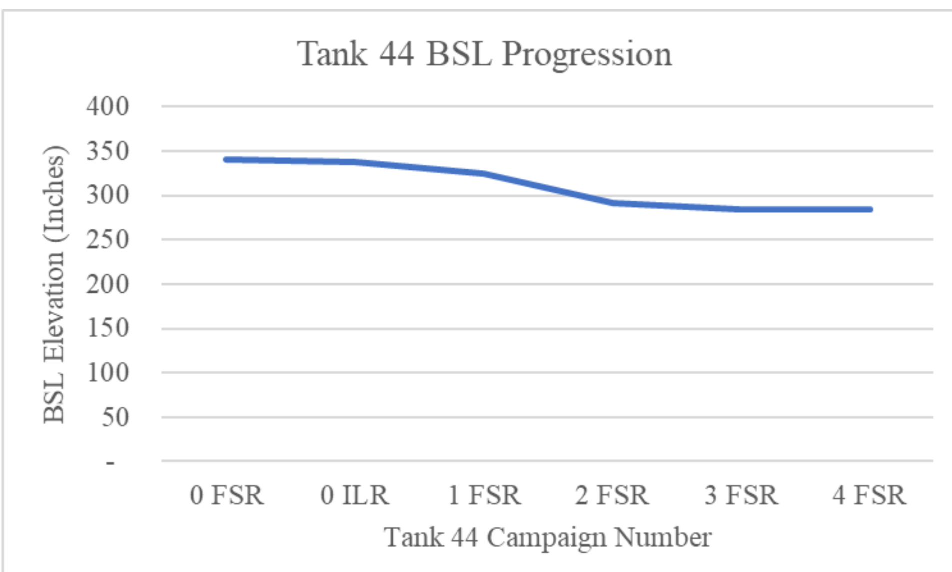

Fig. 7. Tank 44 BSL Progression.

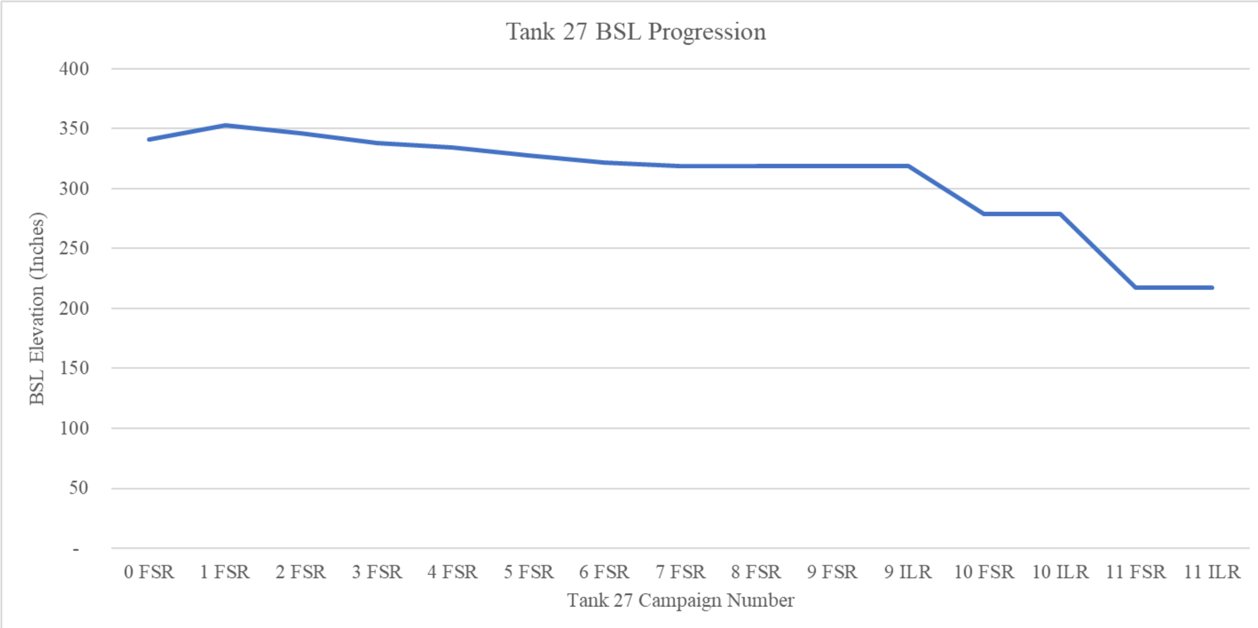

Fig. 8. Tank 27 BSL Progression.

The isolation of cooling coils or placing cooling coils in standby is an ideal way to ensure a salt tank stays relatively warm (at or above 35 degrees C). Placing cooling coils in standby should be performed multiple months prior to initiating the operational phase (prior to first FSR transfer or water addition) of salt dissolution projects. This will provide the time necessary for the waste tank to warm at or above the 35 degrees C mark. Since salt dissolution is an endothermic process and the use of LVMJs and an STP adds little heat to the waste tank environment, isolation of cooling coils or placing cooling coils in standby has not warmed either Tank 27 or Tank 44 above high temperature limits specified in roundsheet procedures that protect DSA programmatic limits.

Due to the success of this overall salt dissolution methodology, similar modifications are in various stages of implementation on a number of other waste tanks to perform this same salt dissolution methodology.

REFERENCES

1. X-CLC-F-00840, Revision 7, "Tank 27 Interstitial Liquid Removal and Salt Dissolution GRM Evaluation".
2. X-ESR-G-00051, Revision 0, "Evaluation of Salt Dissolution for Waste Tank Receipts and Waste Tank Agitation".
3. SRNL-STI-2021-00346, Revision 0, "Residual Insoluble Solids Expected from Saltcake Dissolution".