The Utility of Waste Tank Historical Reviews in Bulk Waste Removal Operations at the Savannah River Site – 25271

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ABSTRACT

Savannah River Mission Completion (SRMC) is actively working to remove, treat, and dispose radioactive waste generated by the separations facilities at the Savannah River Site (SRS) since initial operations in the 1950s. This liquid waste has since been stored in 51 large underground waste tanks at the site. These waste tanks may contain up to 4,921 m^3 (1.3 million gallons) of radioactive waste each in the form of saltcake, sludge, or supernate. SRMC's contract is to treat and dispose of this waste, clean the tanks, and operationally close them. To date, 8 of the 51 waste tanks have been operationally closed.

Removing and treating the waste from the tanks involves detailed planning to ensure the safety of the operations, minimal impacts to the surrounding environment, and proper stewardship of available resources. As part of this planning, one key aspect is the development of technical evaluations, such as gas release evaluations and flowsheets to include controls for the minimization of corrosion, and the prevention of flammability related events. A gas release evaluation is performed to ensure that the hydrogen generated by the radiolytic decomposition of water and thermolytic decomposition of organic materials is safely released in a manner such that the hydrogen concentration present in the vapor space of the tank does not encroach upon the Lower Flammability Limit (LFL). Based on previous saltcake core samples, there is a possibility of entrained sludge in waste tanks containing saltcake. The trapped gas fraction is greater for sludge versus saltcake; therefore, it is important to determine the possibility of the presence of entrained sludge if no saltcake core sample is available. If entrained sludge may be present within the saltcake, the amount must be estimated in order to ensure allowable trapped gas controls are maintained. The flammability program allows for the use of process knowledge of transfer history to conservatively estimate the amount of entrained sludge in saltcake where core samples are unavailable. In preparing gas release evaluations, a knowledge of the history of the waste tank is a valuable asset.

Historical information can provide valuable insight into waste layering within the tank, waste composition, and other potential challenges. A historical review can prevent significant delays should an unexpected condition be identified that may prevent equipment installation or impact the waste removal strategy. Accounting for entrained sludge in saltcake, if necessary, will prevent challenging the LFL and ensure the vapor space does not enter a flammable condition during waste removal. The data collected may also support salt and sludge batch planning, ensuring accurate waste compositions are considered. A report on the tank farm history may be developed from known information regarding waste transfers from the canyons, transfers between tanks, monthly reports from SRS canyon operations, tank level and sounding reports, and existing waste sample results. Gathering this data can be challenging, as sources for this information may be dated, have varied classification levels, include legibility and transcription issues, and lack standardization. These files may also be scattered across multiple file locations or only be available in paper form. This presentation seeks to capture the benefits and reasons for developing waste tank histories, identifying the potential applications for this data, detail the data sources, and finally identify successes and challenges in creating tank histories.

INTRODUCTION

SRMC is actively working to remove, treat, and dispose radioactive waste generated by the separation facilities at SRS since their initial operations in the 1950s. The separation facilities at SRS have produced nuclear materials for a variety of purposes, particularly national defense, and continue to support the disposition of spent fuel through the Accelerated Basin Deinventory program. In almost 70 years of operation, nearly 625,000 m^3 (165 million gallons) of radioactive waste have been generated and transferred to the tank farm facilities at SRS [1]. As a result of volume reduction (e.g., evaporation) and waste solidification (e.g., vitrification), approximately 127,000 m^3 (33.5 million gallons) of material remain as of June 30, 2024 [2]. This liquid waste has since been stored in 51 large underground waste tanks present on the site. These waste tanks may contain up to 4,921 m^3 (1.3 million gallons) of radioactive waste each in the form of saltcake or sludge. SRMC's contract is to treat and dispose of this waste, clean the tanks, and operationally close them. To date, 8 of the 51 waste tanks have been operationally closed. Waste retrieval and tank closure activities are ongoing in an additional 17 tanks through either operations in the field or in design [3].

Each of the 51 waste tanks within the two tank farm facilities (H-Tank Farm and F-Tank Farm) have been fabricated from carbon steel. This material was standard at the time of fabrication but was also selected due to general availability and economics of the material. Within the separations facilities, much of the process equipment and piping was fabricated from stainless steel as the Plutonium Uranium Reduction Extraction (PUREX) process was nitric acid based, which required stainless steel for corrosion. Due to the selection of carbon steel in the tank farms, the process waste streams sent to the tank farms require neutralization, often with sodium hydroxide. The neutralization process results in the formation of three general waste forms that are found in the waste tanks: sludge, supernate and salt. Upon neutralization, the heavier metals, such as aluminum from cladding, or remnant uranium and plutonium from the separations process precipitate out and form a sludge layer at the bottom of the tank. The liquid remaining above the sludge forms an alkaline supernate layer. This layer was often concentrated through the use of evaporators in order to reduce the total volume of waste; however, the evaporation process would tend to cause the formation of sodium nitrite and sodium nitrate salt wastes as the concentrates cooled [4].

An integrated clean-up process has been implemented at SRS in order to treat and dispose of the wastes found within the tank farms. Sludge materials in the tank are consolidated into sludge batches that are sent to the Defense Waste Processing Facility (DWPF) to be vitrified. The vitrified material is poured into steel canisters, which are subsequently placed into interim storage at the site. Salt within the tank is dissolved and mixed with supernate to form salt batches. These salt batches are sent to the Salt Waste Processing Facility (SWPF) where the salt is decontaminated. The decontaminated salt solution is sent to the Saltstone Production Facility where it is mixed with grout and placed into large Saltstone Disposal Units for final disposal. The separated cesium and strontium/actinide bearing solutions are subsequently sent to DWPF to be vitrified. A high-level overview of this process is seen in Figure 1. [1]

The first step of this integrated process is bulk waste removal from the tanks to support the formation of salt and sludge batches. In planning for bulk waste removal and other waste tank closure activities, a tank specific flowsheet is prepared to ensure that the necessary process and safety requirements are met. The flowsheet addresses flammability controls due to the potential for radiolytic and thermolytic hydrogen formation within the waste, as well as the release of trapped hydrogen gas during sludge agitation and/or salt dissolution. In addition, corrosion controls are established to ensure that the chemistry and temperatures within the tank are kept within pre-established limits. The preparation of the flowsheet requires knowledge of the process equipment to be utilized as well as their individual equipment needs. In identifying both flammability and corrosion controls, the waste tank contents and layering must also be well understood.

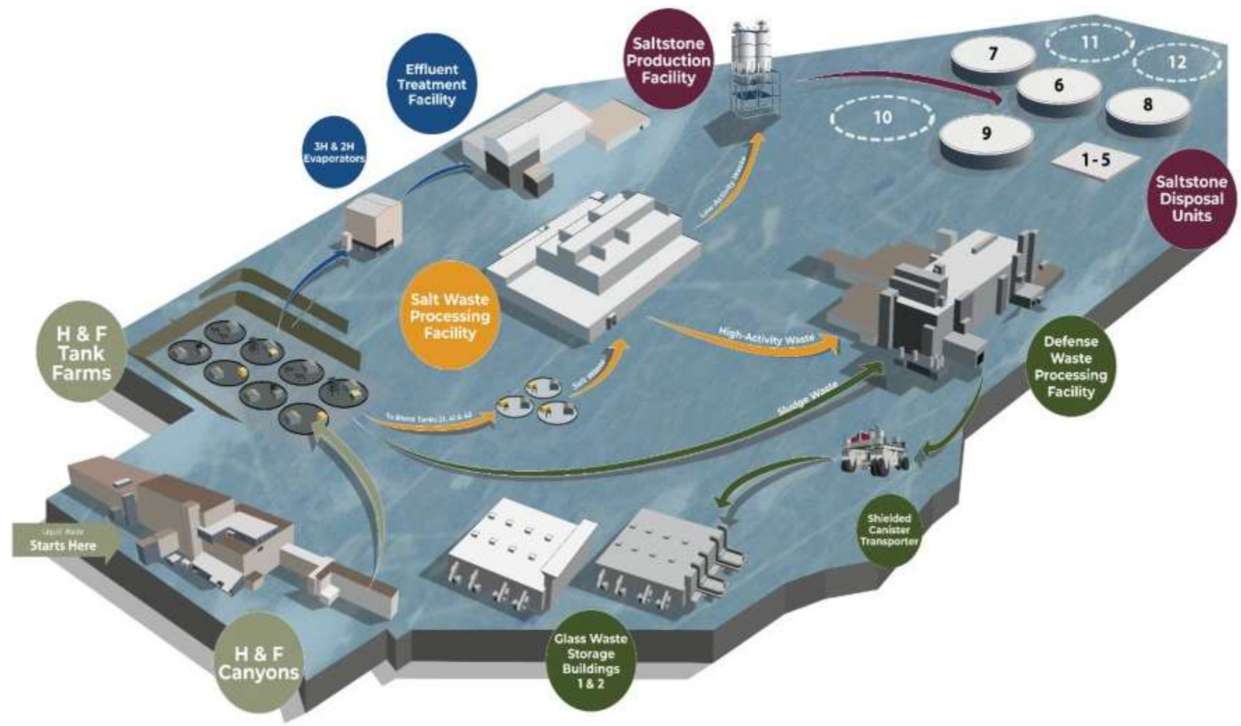

Figure 1. Overview of SRS Liquid Waste Facilities [3]

While the identification of process equipment is straightforward, the characterization of the waste and its layering is not as easily identified. The overall volume of waste within a tank is continuously monitored on most tanks by utilizing a reel tape measurement device that detects the liquid level by using a conductivity probe. This measurement is further recorded within daily reports. However, to measure the solids (e.g., salt, settled sludge, or slurried sludge) height, a physical measurement must be taken in the tank, often using a steel tape measure or steel rod. In order to reduce exposure and dose to the operators, these measurements are not taken as frequently, and often only upon request. Similarly, while the tank chemistry is vital to ensure that the corrosion control program is adhered to, sampling is performed at a frequency established by the corrosion control program, unless other sample measurements are requested (e.g., to support flammability program, salt dissolution, inhalation dose potential or in determining high dose vs. low dose transfers) [5]. In utilizing sample results, the tank conditions at the time of sampling must also be considered, such as whether or not the tank was recently mixed, if there is the potential for a stratified supernate layer, and the location of the sample (e.g., surface or a variable depth). While samples of salt and sludge solids exist for some tanks, these sample types are not common.

In lieu of direct data from the tanks, a review of historical data can provide a better understanding of a waste tanks layering and waste characteristics. By investigating the events and activities related to a waste tank since its first receipt, conservative estimates of salt and sludge volumes may be generated, as well as the potential depths of these layers, which otherwise would not be able to be determined unless a core sample is taken. Information on a tanks' history may be found in records of waste transfers from the canyons, transfers between tanks, monthly reports from SRS canyon operations, tank level and sounding reports, and existing waste sample results. By compiling this information, the flowsheet can provide optimized controls for conditions that may occur during bulk waste removal and closure of the waste tank.

DISCUSSION

Benefits and Reasons for Developing Waste Tank Histories

Historical information can provide valuable insight into waste layering within the tank, waste composition, and other potential challenges. A historical review can prevent significant delays should an unexpected condition be identified that may prevent equipment installation or impact the waste removal strategy. Accounting for entrained sludge in saltcake, if necessary, will prevent challenging the LFL and ensure the vapor space does not enter a flammable condition during waste removal. Information on the waste layering, composition, types of solids and their impacts on gas release (or flammability) evaluations, and salt and sludge batch recipe planning are benefits of historical documents.

Flowsheet Development Waste Layering and Composition

Historical documents can provide insight into the potential layering within a waste tank. A waste tank could consist of sludge on top of saltcake or saltcake on top of sludge or even multiple layers of each. The data collected can determine the positions of the layers to inform decisions made on the waste removal strategy, the type of equipment installed, and assumptions made for flowsheets and/or gas release evaluations. Additionally, historical information can help predict the compositions of the various types of waste in each tank. For example, depending on the composition of some sludge, the rheology may lead to difficulties in mobilizing the sludge with mixing pumps. This could be helpful to know before the mixing pumps are installed to ensure they are placed in the correct waste tank risers to effectively reach any problem-areas within the waste tank.

Also, it has been seen that sludge containing high weight percents of aluminum may be appropriate candidates for a process called Low-Temperature Aluminum Dissolution (LTAD). This process consists of adding concentrated sodium hydroxide to a waste tank then raising and maintaining the temperature to approximately 70°C via mechanical heat of mixing pumps [6]. The information collected for historical documents can help predict if processes such as LTAD may be needed for waste removal.

The Flammability Program Description Document requires that for waste tanks undergoing trapped gas release activities, hydrogen gas trapped in insoluble solids shall be accounted for in the spontaneous time to LFL, seismic time to LFL, quiescent time and subsequent trapped gas release calculations. In salt tanks, insoluble solids have been observed to form following the dissolution of salt. In addition to these solids, some saltcake has been observed to include entrained sludge. This entrained sludge must also be considered for hydrogen trapped gas release activities [7].

The first type of insoluble solids to be considered in gas release evaluations are insoluble solids that are precipitated or released during salt dissolution. A variable depth sample taken following a saltcake dissolution campaign in Tank 9H showed an unexpected high quantity of solids [8]. These insoluble solids were found to be mostly gibbsite, a mineral form of aluminum hydroxide [8, 9]. It was found that the aluminum hydroxide solids have a high propensity to be precipitated during saltcake dissolution as the chemistry changes. As saltcake is dissolved, the hydroxide concentration of the interstitial liquid decreases. The solubility of gibbsite and bayerite are dependent on the hydroxide concentration. At lower hydroxide concentrations, the solubility of the aluminum hydroxide compounds decrease [8]. This leads to the potential to precipitate the aluminum hydroxide insoluble solids during saltcake dissolution.

Due to the discovery of these insoluble solids in a waste tank expected to contain only saltcake, previous saltcake core samples and data taken from actual salt dissolution campaigns were examined to estimate a volume of insoluble solids formed based on volume of salt dissolved. The results of the review showed 16 volume percent of the saltcake dissolved would bound the potential formation of insoluble solids during salt dissolution. Additionally, as the insoluble solids were found to be composed of primarily non-radioactive isotopes, they were not considered to contribute to the heat load of the waste tank [8]. The insoluble solids were assumed to retain trapped hydrogen similar to slurried sludge. It was stated that this volume percent applies to saltcake with a typical minimal amount of entrained sludge but may not apply to saltcake with significant entrained sludge.

The second type of solids to be considered in gas release evaluations are sludge solids entrained in the salt matrix. Entrained sludge solids have been observed in Tank 44F. From 1982 – 1992, Tank 44F received concentrated waste from the 242-16F evaporator, which was fed by Tank 26F. During the same time period, major relevant inter-tank transfers into the Tank 26F were from PUREX Low-Heat Waste (LHW) Tanks, including Tank 44F. The liquid waste in Tank 44F was further concentrated by recycling waste to Tank 26F to be fed back to the evaporator. Therefore, the historical study completed in 2006 concluded Tank 44F to be a waste tank containing homogeneous saltcake as the waste was mainly from precipitation of concentration PUREX LHW [10]. No sludge transfers occurred in or out of the tank [11, 12].

Following the historical study, eleven saltcake core samples were obtained. The samples are shown in Figure 2.

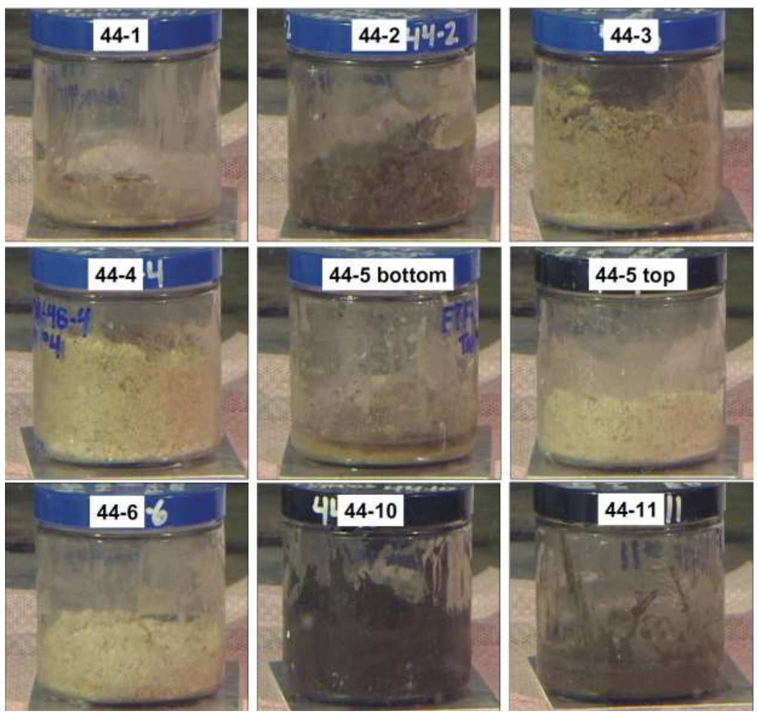

Figure 2. Photographs of the Tank 44 Segments in 500 mL glass jars [Ref. 11]

Samples 44-1 through 44-6 were taken from the 723.9 to 434.34-cm (285 to 171-inch) tank level while Samples 44-10 and 44-11 were taken from the 289.56 to 193.04-cm (114 to 76-inch) tank level. Tests were completed on these samples to measure hydrogen generation rates and characterize the solids [11]. The tests simulated saltcake dissolution that is done during bulk waste removal in the waste tanks. Once salt dissolution was complete, the supernate and any solids that were remaining were sampled and analyzed to reconstruct the composition of the upper and lower saltcake segments. Figure 3 represents the major components in the upper and lower segments of Tank 44F.

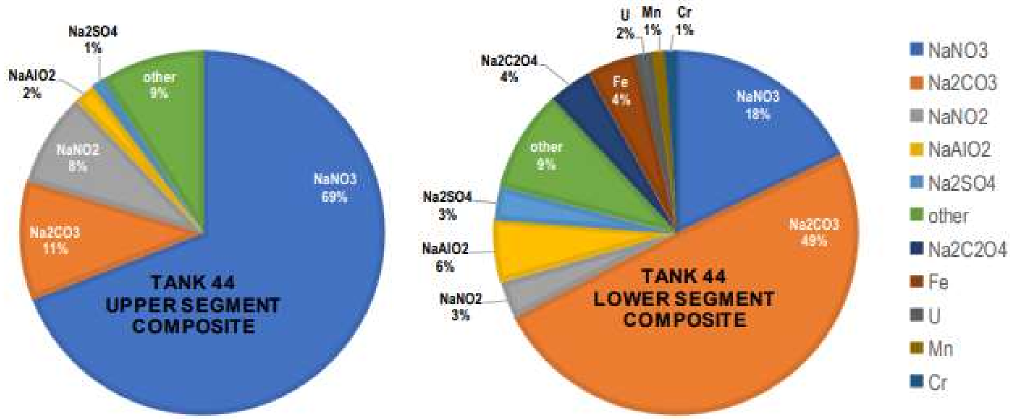

Figure 3. Representation of major saltcake components in the Tank 44 upper and lower segment composites [11]

Figure 3 shows the upper segments (723.9 to 434.34-cm or 171-to-285-inch tank level) contain approximately 69% sodium nitrate while the lower segments (289.56 to 193.04-cm or 76-to-114-inch tank level) contained 49% sodium carbonate. Additionally, the lower segments were shown to contain 8% compounds typically representative of sludge (i.e. iron, uranium, manganese and chromium). This was found to be atypically large when compared to previous saltcake sample characterized at Savannah River National Laboratory (SRNL) [11]. Through study of the monthly reports for Tank 44F, it was posited this layer was established in 1983. During that time, Tank 44F acted as a receipt tank for the 242-16F evaporator. Other tanks that were receiving from the 242-16F evaporator during the same time period are Tanks 28F, 45F and 47F [7]. The discovery of the increased amount of sludge solids found in Tank 44F led to the proposition of similar entrained sludge solids in other salt tanks.

As part of this preparation for a waste tank planned to undergo waste removal, one key aspect is the development of technical evaluations, such as gas release evaluations and flowsheets to include controls for the minimization of corrosion, and the prevention of flammability related events. A gas release evaluation is performed to ensure that the vapor space hydrogen concentration does not exceed the 60% of the LFL. In order to attempt to estimate the amount of entrained sludge solids, monthly reports and transfer histories are examined for the applicable waste tank. The sludge content may contribute to the overall heat load and volume of trapped hydrogen released during waste removal. The trapped gas fraction is greater for sludge versus saltcake; therefore, it is important to determine the possibility of the presence of entrained sludge if no saltcake core sample is available. If entrained sludge may be present within the saltcake, the amount must be estimated in order to ensure allowable trapped gas controls are maintained. The flammability program allows for the use of process knowledge of transfer history to conservatively estimate the amount of entrained sludge in saltcake where core samples are unavailable. In preparing gas release evaluations, a knowledge of the history of the waste tank is a valuable asset.

As discussed previously, during salt dissolution activities in Tank 9H, solids were discovered in a variable depth sample. Analysis of the solids indicated they were mostly aluminum-based (including aluminum hydroxide, aluminum oxide, and aluminum silicate) and did not dissolve in water [8]. Given that aluminum hydroxide is one of the four main components of sludge, the insoluble solids will be conservatively treated as slurried sludge for the purposes of trapped gas retention and release [7]. Based on previous salt dissolution campaigns, an insoluble solids volume percent of 10% (i.e., 0.1 volume of insoluble solids formed per 1 volume of bulk saltcake dissolved) can be used to determine the volume of insoluble solids generated during saltcake dissolution [13]. The volume percent of insoluble solids generated during saltcake dissolution may be greater than 10 vol.% if the dissolved saltcake contains significant amounts of entrained sludge; therefore, the recommended value is applicable to salt dissolution of saltcake with a typical minimal amount of entrained sludge, and is applicable to tank farm saltcake dissolution regardless of the specific dissolution method employed [7].

Historical evaluations on waste tanks containing saltcake estimate the potential for the presence of entrained sludge. If it is thought entrained sludge could be present, a conservative volume is calculated based on previous transfers into the waste tank. In order to consider a transfer a supernate-only transfer, there must be 60.96 cm (24 inches) of separation between the transfer pump suction and the solids layer [14]. Additionally, depending on the waste tank, the solids settle at varying rates. It is unknown whether these controls were adhered to when reviewing monthly reports. Typically, it is conservative to assume some sludge solids were carried over during transfers from sludge tanks. Engineering judgement is used to determine the potential for sludge carryover. The estimated volume percent of entrained sludge is added to the 10 vol.% of insoluble solids formed during salt dissolution. This results in conservative times to LFL and volume of trapped gas released for waste tanks undergoing salt dissolution.

Flammability evaluations (or gas release evaluations) aim to protect a vapor space hydrogen concentration safety analysis value (SAV). For most waste tanks, the hydrogen concentration SAV is 60% LFL. Prior to the salt dissolution activity, the initial height of insoluble solids (or slurried sludge) is verified via a wafer measurement (for the saltcake height) and a turbidity meter (for the insoluble solids). If there is a positive difference between the turbidity meter measurement and the wafer measurement, that difference is considered to be the height of insoluble solids. The flammability evaluations typically give the maximum water addition (or height of free supernate) for varying heights of initial insoluble solids at varying salt heights. The volume of trapped hydrogen released based on the volume of insoluble solids/slurried sludge initially present is added to the hydrogen released from dissolving the saltcake and is ensured to be less than the hydrogen concentration SAV of 60% LFL. The times to LFL are calculated for each case assuming the volume percent of insoluble solids/slurried sludge (i.e. 10 vol% insoluble solids plus entrained sludge) is released depending on the volume of salt dissolved.

Salt and Sludge Batch Planning

While gathering historical information for salt batch and sludge batch planning is not the primary focus, the development of a more detailed waste layering and composition may support salt and sludge batch planning. In order to ensure that SWPF and DWPF are able to run efficiently, salt batches and sludge batches are composed with material from multiple source tanks so that an optimal feed chemistry may be obtained for both facilities. By having additional information regarding the waste composition and volumes of material, the development of these batch chemistries may be refined.

Appropriate Tanks for a Tank History Document

While detailed tank histories may be necessary for regulatory or waste closure activities, a detailed tank history may not be necessary for the generation of every waste removal flowsheet or flammability evaluation. Several of the tanks within the SRS tank farms are very well characterized or have already undergone bulk waste removal. For these tanks, a detailed history may not provide any new information regarding the waste in the tank relevant for that tank's closure. Instead, a detailed historical review is valuable in several unique circumstances. If a tank is known to have received both supernate and fresh waste from the canyons, then a history document may be able to answer questions regarding the layering of salt and sludge in a tank. Another case is for known salt tanks that have a possibility of entrained sludge, where a historical review may dismiss or better quantify the entrained sludge. One further case where a historical review is beneficial is when there is little recent data regarding a tank. This may be due to tank having become inactive, with no transfers in or out over a certain period of time, or because a salt tank has become dry, with no supernate coverage. For these tanks, a review of the tank's history may provide insights regarding the conditions that may result during initial bulk waste removal.

Available Data Sources

Information that may be used for capturing a waste tank's history is found in a variety of sources, one key source being monthly reports. During construction and at the start of production, E. I. du Pont de Nemours and Company (Dupont) managed operations at SRS. During their tenure at the site, Dupont produced monthly progress reports on the separations activities occurring on the site. These monthly reports summarized the major activities occurring within the SRS separations facilities, including the canyons and associated facilities, tritium processing facilities and other support activities occurring on the site. In the early years, waste tank activities were considered to be part of the canyon activities and thus related tank farm activities were captured in these reports. Initially, as waste activities were considered part of the separation process, the reports would largely only capture basic information such as waste transfer types and volumes, as well as tank level status and temperatures. These reports would also describe significant events or studies regarding the tank farm, such as early studies regarding the vapor space composition of the waste tanks. Over time, as activities increased within the tank farm (e.g., new tank construction, tank to tank waste transfers, evaporator operations), the waste management section of the monthly reports would expand, including data on waste tank levels, fresh waste receipts, available tank inventory, waste tank operations, estimated tank radionuclide inventories, and transfers between tanks.

While the monthly reports contain many useful pieces of information, using the information within has its challenges. Dupont continued to generate the monthly reports through the end of their contract at SRS in 1989. Then Westinghouse continued to maintain these monthly reports, with copies of the monthly reports written up until 1995 being available. Over the 40 years of these reports and through many authors of these reports; the format, content and details found in the reports changed. These reports were largely typed, but at times included hand-drawn figures and graphs. As a result, information that may be found in one month may not be found in the next month or may be located in a different place. Available copies of these reports are largely scanned images and are for the most part not computer searchable. These scanned copies further result in legibility issues as the quality of images and text has been negatively impacted. Scanned versions of monthly reports largely reside within the liquid waste organization electronic document library. This library is not considered an Official Site Records Repository but is rather an accessible location for documents needed in support of liquid waste operations. As such, it does not contain every monthly report, but rather those that have been entered into it. In addition, as the early monthly reports were not specific to just waste tanks, some of these reports contain controlled information, while others have been modified so that they contain information only pertinent to the liquid waste program. Later monthly reports were specifically written to just contain liquid waste information, with a separate report being written to capture other separations activities.

In addition to monthly reports, historical information on the waste tanks is also found in other reports for the tank farms. These include transfer and waste receipt records that have been transcribed from data found in the monthly reports, tank level and sounding records, and waste sample results. In addition, several of the early waste tanks have had individual history documents written in the past, including tanks 1-4(F), 9-11(H), 14H, 23H & 24H; where history documents were written in the late 70s capturing the waste tank history through 1974. Information in these records share many of the same challenges as the monthly reports, with issues related to scan quality, transcription errors, and standardization being prevalent.

Successes for Tank Histories

In recent years, historical reviews of tanks have provided valuable information for both flowsheet generation and waste removal activities. Specific examples of these successes are provided for tanks 26F, 28F and 14H.

Tank 26F

Waste retrieval operations were performed in Tank 26F in 2020 to provide sludge for Sludge Batches 10 and 11 [15]. Initial preparations for waste removal, including equipment installation were performed in 2016 [15]. In preparation for waste removal, there were questions regarding the layering in the tank due to inconsistent soundings. As a result, an examination of the transfers into and out of the tank was performed, identifying a suspected salt layer on top of the sludge [16].

Following initial waste agitation operations, the material did not behave in a manner consistent with salt or sludge. Upon further review, it was found that the material had characteristics indicative of a blend of salt and sludge and would need special consideration under the flammability program. The initial results, coupled with the examination of the tank's history permitted a revised flammability evaluation and subsequently a successful waste removal campaign was performed in Tank 26F. An additional outcome of this campaign was that an extent of condition review was performed to identify other tanks that may have similar waste compositions [12]. The Tank 26F layering document set a precedence for developing history documents for other tanks undergoing solids removal.

Tank 28F

Tank 28F is planned to undergo bulk saltcake dissolution efforts in support of SWPF operations, with equipment installation having already commenced. Tank 28F was initially placed into service in 1980, receiving supernate from Tank 18F [17, 18]. It subsequently received 242-16F Evaporator concentrate from February 1980 – September 1985 [18]. Tank 28F has no documented sludge level [18]; however, based on the operational history of Tank 28F and a salt core sample taken from Tank 44F, it is conjectured that some sludge solids may be present in the tank [7]. A saltcake core sample was pulled from Tank 28F in 2006 and was analyzed by SRNL. Of the saltcake samples that SRNL was able to analyze, no samples were declared to contain abnormal quantities of sludge solids; however, several core samples that would correspond to the time frame where entrained sludge is suspected were found to be empty of saltcake [19]. To support the flammability evaluation for Tank 28F and reconcile the core samples without saltcake, a historical evaluation of the tank was performed to investigate the possibility of sludge solids entrained in the saltcake.

Figure 4 graphically depicts a summary of the conjectured saltcake layering in Tank 28F based upon historical information in the monthly reports, tank farm waste receipt data, and waste tank transfer data. Figure 4 also provides visual information related to the saltcore sample data collected in 2006 [19]. In some instances, Tank 26F receipts are identified as these would be the potential source of any sludge solids. During the time period that Tank 28F was receiving evaporator concentrate from the 242-16F evaporator, this evaporator was being fed from Tank 26F [17]. This saltcore data shows the mass of material collected in each sample as well as the distribution of sample material between saltcake and free liquid. The chart also identifies the aluminate content present in each saltcore and provides a general depiction of the material being fed to the 242-16F evaporator and its timeline. Finally, a dotted line provides a graphical depiction of the salt level reported in monthly reports for Tank 28F from 1980 to 1994. This line can provide a general guideline to when salt layers are believed to have formed in the tank and can easily be compared to the saltcore samples. The historical review performed for Tank 28F is sufficient to support assumptions necessary for both the flammability and flowsheet evaluations.

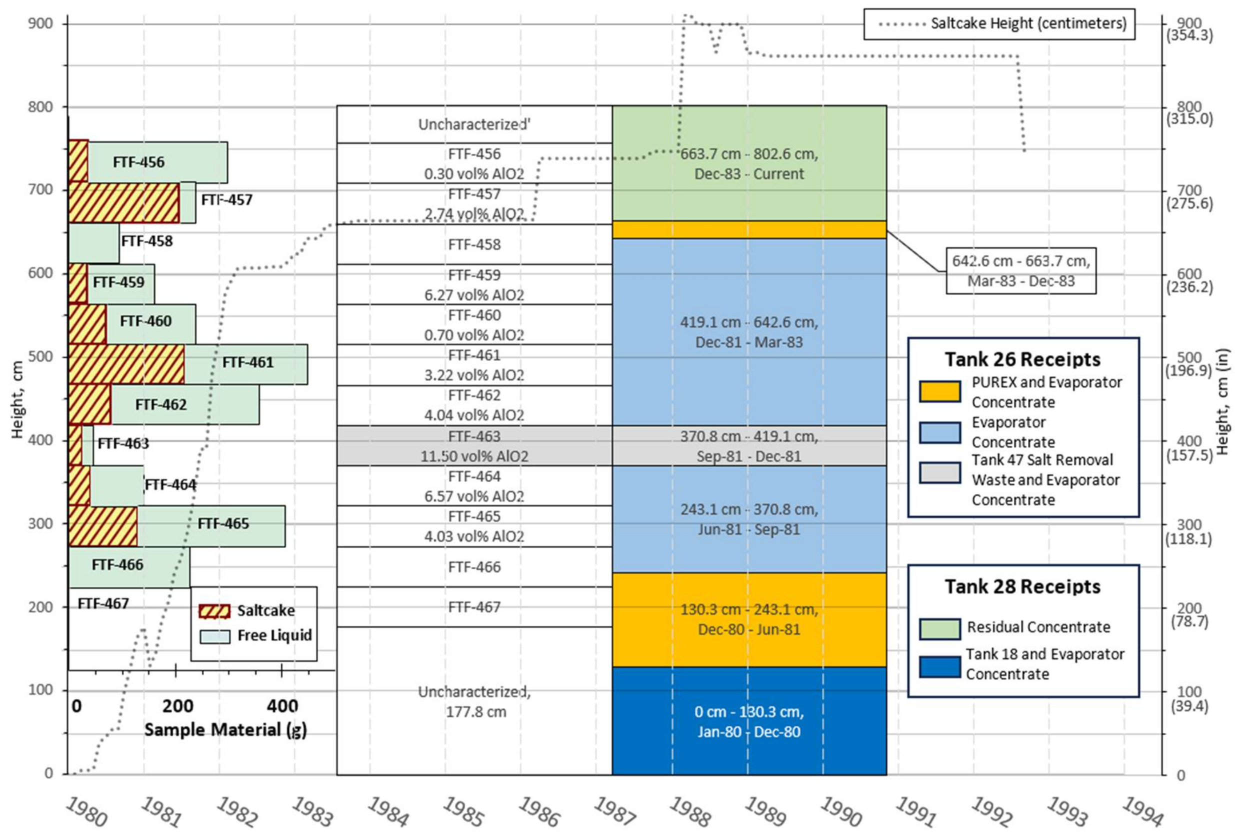

Figure 4. Conjectured Tank 28F Saltcake Layering

Tank 14H

Tank 14H is anticipated to undergo final waste removal in preparation for a Preliminary Cease Waste Removal declaration in 2025. Tank 14H entered into service as a waste receipt tank in September 1957. It subsequently had four distinct activity periods during its service life. It served as a canyon receipt tank, during which time it accumulated 28 inches of sludge. It then proceeded through a sludge removal campaign and entered into salt and supernate storage operations. Finally, due to leaks in the tank walls, Tank 14H has had a long period of dormancy with no transfers in or out. During this time, the supernate slowly evaporated, concentrating the supernate and causing salt to form. The tank was declared dry in June 1986 after an attempted sample failed to return any liquid. As the tank received both salt and sludge, and due to the lack of any recent chemistry data, a historical review was performed to better characterize the waste remaining within the tank. [20]

Based on the process history of the tank, a revised estimate of the waste contents, including both salt and sludge was made. This process history also allowed for an estimate of the quantity of entrained sludge, the additional heat content of this sludge, and the anticipated supernate Cs-137 content to be made [20]. Each of these values are important inputs to the flammability evaluation for the tank.

Finally, during the review, a record of an investigative report written at the end of 1993 was uncovered. This report detailed an incident in the tank where the control room received an alarm from the Tank 14H Waste Tank Conductivity Probe High Level Alarm. This is peculiar as the tank was dry by that point in time. Per the incident description, the 1H control room operator received the alarm and initiated the response procedure. A 10-inch difference was observed between the reel tape and the control room read out. The investigation noted that the waste tank contains solid salt material and that this salt level may be uneven across the tank, leading to discrepancies between the reel tape and steel tape. On this tank, the steel tape area is approximately 12 meters (~40 feet) away from the reel tape. As the tank has been considered dry, there were very few salt level measurements since that time, each within a common riser. Upon uncovering this investigative report, new salt measurements were taken in different locations across the tank and have indeed found an uneven salt layer that is higher than anticipated on one side of the tank [20]. This information has now been taken into consideration in the flammability evaluation as well as by the project team. Advanced knowledge of the higher salt shelf will enable for proper planning by the Tank 14H project team as they work to install mixing pumps in that area of the tank.

CONCLUSIONS

A well-researched waste tank process history can be a valuable asset in preparing and executing plans for liquid waste retrieval. A knowledge of fresh waste receipts and transfers between tanks can provide information on the contents and layering within a tank that is necessary in developing process flowsheets and performing flammability evaluations. Historical reviews of several SRS waste tanks have further provided insight into unexpected conditions that have occurred during waste removal (e.g., Tank 9H, Tank 26F), insight into the potential for entrained solids (e.g., Tank 44F, 28F & 14H), and clues regarding tank conditions following long inactive periods (e.g., Tank 14H). These reviews are appropriate for tanks that are undergoing bulk waste removal, have had a history of receiving both fresh waste and evaporator concentrate, or that have been inactive for a long time. Information is available from a variety of sources; however, gathering this information can be challenging due to the use of multiple storage locations, varied information security requirements, document and image quality, and potential transcription errors.

As the treatment of the waste and closure of tanks continues, information gathered from actual waste removal campaigns can also be used to continuously improve the waste removal strategies for other waste tanks. The aim of SRMC is to provide a comprehensive risk-based methodology to remove, treat and dispose radioactive waste generated by the separations facilities at SRS. Historical documents contribute to the mission of SRMC by ensuring safe operations for waste tanks undergoing waste removal and closure activities, as well as preparing salt and sludge batches to ensure consistent and compliant feeds for downstream facilities.

REFERENCES

1. D. P. CHEW and A. W. JUNG, "Liquid Waste System Plan," Savannah River Mission Completion, Tech. Report. SRMC-LWP-2023-00001, Rev. 23, March 2023.
2. D. P. CHEW, "Savannah River Site – Waste Tank Levels," Savannah River Mission Completion, Tech. Report. SRMC-LWP-2022-00001, Rev. 84, 30 June 2024.
3. J. MAUL and M. BORDERS, "Liquid Waste Program: Risk Reduction and Waste Removal Update," Presentation to the SRS Citizens Advisory Board, Aiken, SC, July 29, 2024.
4. M. B. REED, M. T. SWANSON, J. TYSON, and T. D. GILLET, *Bringing it to Form, A Thematic Study of Savannah River Sites's Separations Processes, F and H Areas*, New South Associates, Stone Mountain, Georgia (2013).
5. K. MARTIN, "CSTF Corrosion Control Program," Savannah River Mission Completion, Tech. Report. WSRC-TR-2002-00327, Rev. 10, July 2024.
6. M. T. KEEFER, S. G. CAMPBELL, D. J. CLARK, M. D. BUXTON, "Sludge Heel Removal by Aluminum Dissolution at Savannah River Site – 12390," presented at WM Conference, Phoenix, AZ, USA, Feb. 26 – March 1, 2012, SRNL-STI-2012-00022, Rev. 0.
7. H. BUI, "CSTF Flammability Control Program," Savannah River Mission Completion, Tech. Report. WSRC-TR-2003-00087, Rev. 44, June 2024.
8. C. J. MARTINO, "Residual Insoluble Solids Expected from Saltcake Dissolution," Savannah River National Laboratory, Tech. Report. SRNL-STI-2021-00346, Rev. 0, July 2021.
9. S. C. HUNTER, "Insoluble Solids From Salt Dissolution: Characterization and Testing," Savannah River National Laboratory, Tech. Report. SRNL-STI-2023-00166, Rev. 0, October 2023.
10. H. Q. TRAN, "Tank 44F History from 2/28/1992 to 2006," Tech. Report. CBU-PIT-2006-00101, Rev. 0, "June 12, 2006.
11. C. J. MARTINO, J. M. PAREIZS, W. H. WOODHAM, "Investigation of Thermolytic Hydrogen Generation Rate in Tank 44 Dissolved Saltcake Samples," Savannah River National Laboratory, Tech. Report. SRNL-STI-2019-00730, Rev. 1, August 2021.
12. S. ISOM, J. BENEDICT, J. HARRIS, "Extent of Condition Review of High-Level Waste Tanks," Savannah River Remediation, Tech. Report. SRR-LWP-2019-00044, Rev. 0, September 12, 2019.
13. G. BLACKBURN, "Insoluble Solids Generation from Salt Dissolution Calculation for Tank Farms," Savannah River Mission Completion, Tech. Report. X-CLC-G-00135, Rev. 0, August 2023.
14. I. VERRET, "CSTF Sludge Carryover Minimization Program," Savannah River Mission Completion, Tech. Report. WSRC-TR-2003-00089, Rev. 0, June 2024.
15. J. CANTRELL, "SRS Waste Removal and Tank Closure (An Historical Perspective)," SRR-TCR-2020-00002, April 2021.
16. P. A. BERNOT, "Tank 26F History and Layering," Savannah River Mission Completion, Tech. Report. X-ESR-F-00186, Rev. 1. April 2016.
17. "Tank 28F History, From 1980 to 2005," Tech. Report. CBU-PIT-2005-00051, Rev. 0, March 2005.
18. W. S. CAVIN, A. T. CRUM, "Waste Transfers and Miscellaneous Additions," Tech. Report. WSRC-TR-93-425, Rev. 1, 21 January 1994.
19. "Analysis of Tank 28F Saltcake Core Samples FTF-456-467," Tech. Report. WSRC-STI-2006-00151, Rev. 0, 28 Feb. 2007.
20. P. HENRY, "Tank 14H History and Layering," Savannah River Mission Completion, Tech. Report. X-ESR-H-01232, Rev. 0, August 2024.