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The Destination and The Journey: Safely Navigating Waste Transfers in the SRS Tank Farms – 22101

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ABSTRACT

A journey around a Savannah River Site (SRS) Tank Farm is illustrated through the eyes of a transfer engineer to highlight the importance of performing waste transfers in a safe and efficient manner. To better understand the tasks assigned to transfer engineers, the process of transfer development and execution will be explained parallel to the preparation and experience of travelling. Much like one prepares for a trip and completes all the necessary preparations to ensure they reach their destination safely, transfer engineering is filled with a series of requirements, evaluations, reviews, and procedures to guarantee the safe transfer of materials.

The SRS Tank Farms consist of two Concentration, Storage, and Transfer Facilities (CSTF): F-Tank Farm and H-Tank Farm. These two facilities contain 51 underground storage tanks, 8 of which are operationally closed, to aid in the intermediate storage of radioactive liquid waste at the SRS prior to processing into streams for either stabilization and safe long-term storage at the Defense Waste Processing Facility (DWPF) or permanent disposal in the Saltstone Disposal Facility. To facilitate the operations in the Tank Farms, there are a series of interconnected transfer lines, diversion boxes, pump pits, and other ancillary structures that provide the means for safe transfer of liquid waste. These transfer structures can be related to the infrastructure used during travel, with transfer lines being the roadways, diversion boxes as major highway intersections, and pump pits similar to gas stations.

Before the start of a trip, it is always necessary to know the rules of the road. Understanding these rules allows for safe travel. Transfer engineering has its own set of rules. The Transfer Control Program Description Document (PDD) provides guidance to engineering and operations for implementing transfer related controls contained in the Documented Safety Analysis (DSA) and Technical Safety Requirements (TSRs) in transfer procedures, evaluations, and the Evaluated Transfer Approval Form (ETAF).

The process of developing a transfer can be broken down into four general sections: the scoping meeting, procedure development, Unreviewed Safety Question (USQ), and transfer execution. The scoping meeting is held in the early stages of planning for the trip. The destination has been decided, and the outcome is to determine what is required to reach your goal. A scoping meeting gathers the transfer engineer, procedure writers, and operations personnel that will be involved in the transfer development. During the meeting, the transfer type, motive force, transfer path, and any requirements are determined. Out of the scoping meeting, a Transfer Route Diagram (TRD) is agreed upon to serve as the map to show the travel path and necessary equipment.

The next step is developing the transfer procedure, essentially the itinerary for the trip. The information laid out in the scoping meeting is organized in such a way to ensure everything goes as planned. The typical arrangement for a transfer procedure is as follows: an introduction, any precautions or prerequisite actions, the transfer itself, and any post-transfer requirements. The transfer procedure draft is written by the procedures group, then goes through a series of organizational-wide reviews to guarantee all requirements are met and the transfer can be performed in the field.

Once the transfer procedure is completed, a transfer engineer is required to complete a USQ to ensure the actions are covered by the DSA. The USQ is the final stages of planning for the trip, giving the confidence there are no road closures or inclement weather that could derail the travel plans. The transfer is assessed for potential hazards involved and necessary actions for prevention are determined. For example, siphon potentials and breaks are identified, pump speeds are limited, and the potential for salt to precipitate out into the transfer lines, salt-out, are analyzed.

With everything planned, reservations must be made. The ETAF serves this purpose. The ETAF verifies the transfer details adhere to all applicable chemical and radiological operating limits and controls, then authorizes the transfer to commence. The transfer procedure is executed, data is logged, and the progress is tracked until completion. Transfer engineers complete this rigorous process for every new transfer in the Tank Farm to guarantee the safety of everyone. Every waste transfer completed helps to progress SRR towards its goal of eliminating the risk to the public and environment from the waste held in aging waste tanks.

INTRODUCTION

Transfers are one of the ongoing activities that help drive SRR towards its goal of safely processing nuclear waste. Many different transfer types exist at the site, whether they be between waste tanks, from pump pits, or influent from another facility on site. Annually, the Tank farm completes over 900 transfers, with more than 61 thousand cubic meters [16.1 million gallons] of material being moved throughout the year.

The purpose of the Tank Farm at SRS is the intermediate storage of radioactive liquid waste for future long-term processing. Currently, more than 130 thousand cubic meters [35 million gallons] of waste are present in the underground storage tanks [1]. Processing of the waste is completed through operations involved with the evaporators, Tank Closure Cesium Removal (TCCR), Salt Waste Processing Facility (SWPF), DWPF, Effluent Treatment Facility (ETF), and Saltstone Facility. An overview of the liquid waste operations at SRS can be seen below in Figure 1.

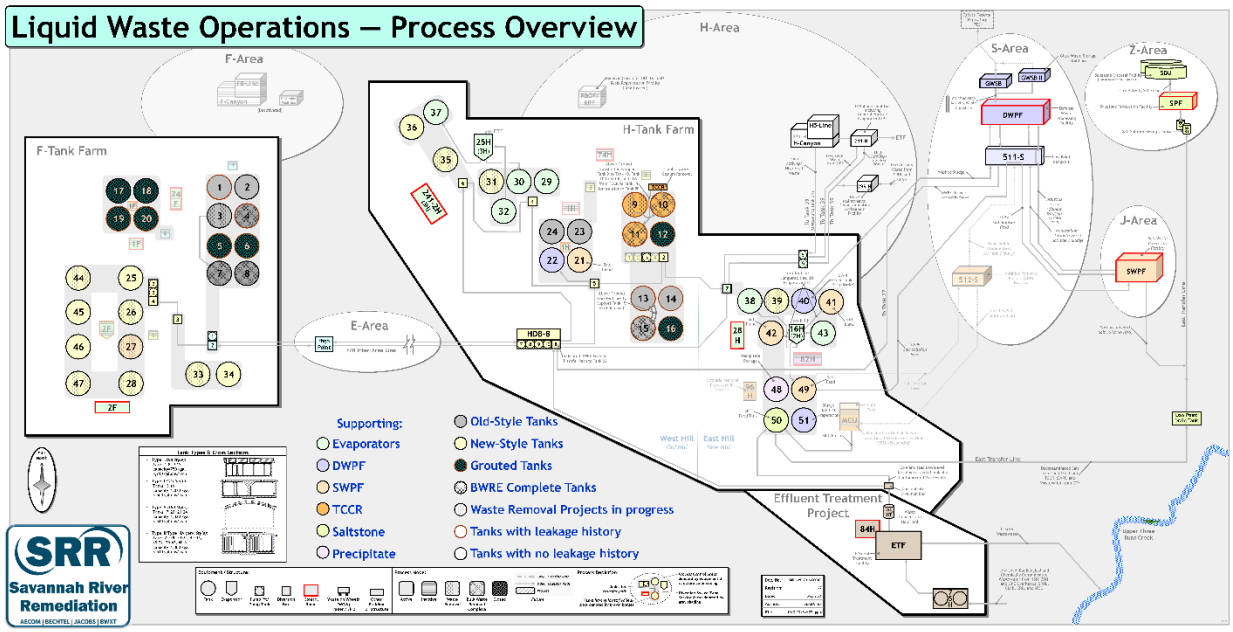

Fig. 1. SRS Liquid Waste Operations – Process Overview. [2]

However, for these operations to occur, the waste must be transferred from the underground storage tanks to their respective destinations. The actions involved with the transfer development and execution process can be illustrated as preparations for a trip around the tank farm. The Transfer Control PDD is the rulebook by which transfer engineers implement requirements into activities. Transfers are initially mapped out to determine the route and equipment needed in the TRD. The itinerary is written by the procedure group in the form of a transfer procedure and the trip is monitored by operations. Transfer

engineering is involved with each step of the process to eliminate inherent hazards and ensure the safe implementation of activities.

DISCUSSION

Transfer Control Program Description Document (PDD)

Before a road trip begins, it is essential to know the rules and regulations for proper travel. The principles of roadway travel are written down as laws to allow safe travel for everyone. Transfer Engineers' set of requirements are written down in the Transfer Control PDD. The Transfer Control PDD provides the guidance to transfer engineers and operations for implementation of controls laid out in the DSA and TSRs. The Transfer Control PDD defines how the laws of the DSA and TSRs are satisfied in the implementation of developing and approving transfers. These requirements are involved with the entirety of the transfer process, from planning to post-transfer activities.

The Transfer Control PDD begins with the determination of transfer type as either High-Rem, Low-Rem, Chemical Cleaning, Sludge Slurry, or Extended Sludge Processing (ESP) Sludge Slurry [3]. Each transfer type has different requirements that must be met for the transfer to take place. If the trip being planned is to the beach, sunscreen must be packed, or to the mountains, heavy jackets. What is needed is determined by the type of trip. For the Tank Farm, the transfer requirements are determined by the waste contents being moved.

Once the transfer type is known, planned travel routes are inspected for further requirements or limitations. In the Tank Farm, there is a vast series of inter-connected transfer lines and structures, which represent the highways and interstate systems that connect the country. Each of these transfer pathways come with different requirements based on the structures and equipment involved. For example, prior to transfer initiation out of Tank 50, valves in the Tank 50 Valve Box must be isolated to preclude material from entering diversion boxes HDB-7 and HDB-8 [3]. Inspecting the transfer route enables the identification of potential inadvertent routes, leak detection locations, isolation points, and equipment specific requirements.

During travel there is always the potential to get off track, so the progress of your trip is tracked to guarantee you are going the right way. In the Tank Farm this is essential because sending waste to the wrong tank could have major downstream implications. The PDD requires independent verification of correct transfer path alignment and motive force used. The independent verification is the watchful copilot guaranteeing the trip is staying on course.

The Transfer Control PDD enforces many requirements both before the transfer takes place and while being performed. The transfer volume must allow for waste tank space availability, while the material must adhere to the limits on Hydrogen Generation Rate (HGR), Inhalation Dose Potential (IDP), and Waste Acceptance Criteria (WAC). Due to the inherent risk of High-Rem transfers there are added precautions: leak detection on the tank riser and an evaluation for the capability of isolation valves.

The Transfer Control PDD is also the driving force for the USQ review. The Transfer Control PDD requires the transfer to be evaluated for potentials of siphon, salt-out, and water hammer, as well as a limiting the transfer pump speed.

Once the transfer begins it must be monitored and any isolation devices must have been identified beforehand for use if needed. Another important requirement of the Transfer Control PDD is flushing the core pipe after waste transfers. Flushing the core pipe within 30 days after waste transfers is necessary to

remove residual waste and keep the IDP below the limit. Even when IDP is below the limit, flushing the line is a best management practice as it improves the condition and longevity of the transfer lines.

Transfer engineers must ensure compliance to not only the Transfer Control PDD, but any other applicable requirements from other programs. This process includes Corrosion and Flammability Control, Waste Characterization, and depending on the transfer type, Evaporator Feed or Sludge Carryover Minimization (SCOM). For example, a post-transfer requirement from the Corrosion Control PDD is to inhibit low points. Low points create a Microbiologically Induced Corrosion (MIC) potential and therefore must be inhibited with caustic before operations complete their pos-transfer activities [4].

Adherence to the Transfer Control PDD, as well as to all other applicable programs, is the first step to ensuring all safety measures outlined in the DSA and TSRs are implemented correctly. Once the requirements for the transfer are known, the planning can begin.

Scoping Meeting

The scoping meeting occurs during the early stages of planning for the transfer process. The destination has been decided and plans are decided upon on how the transfer will be completed. Transfer engineers meet with the procedure group and operations to discuss what is needed to make the activity successful. A Transfer Scoping Meeting Record is completed to define the important aspects that are needed for the procedure development. Included in this record is the transfer type, path, motive force, vent and drain locations, flush water source, and any hazard potentials such as, siphons or salt-out [5]. Once the scoping meeting is complete, the trip has clear definitions on expectations and the transfer route and equipment is mapped out in a TRD.

Included on the TRD are the sending and receipt tanks, transfer lines and structures, and any equipment needed to fulfill the transfer. Additionally, the TRD shows locations downstream of closed isolation valves. The TRD is the map for a transfer, with the starting tank being home, and the pump or jet used for the motive force is identified. Transfer lines are the roads that will be driven, and diversion boxes are the major highway intersections that redirect the waste towards the receipt tank. Along the transfer route, valves and jumpers are the traffic signs directing flow between locations. On long trips, such as inter-area transfers between F- and H-Tank Farms, a refueling station is needed. The pump pits/tanks act as the gas station for the transfer, giving the waste extra motive force needed to reach the receipt tank. An example of a TRD can be seen below:

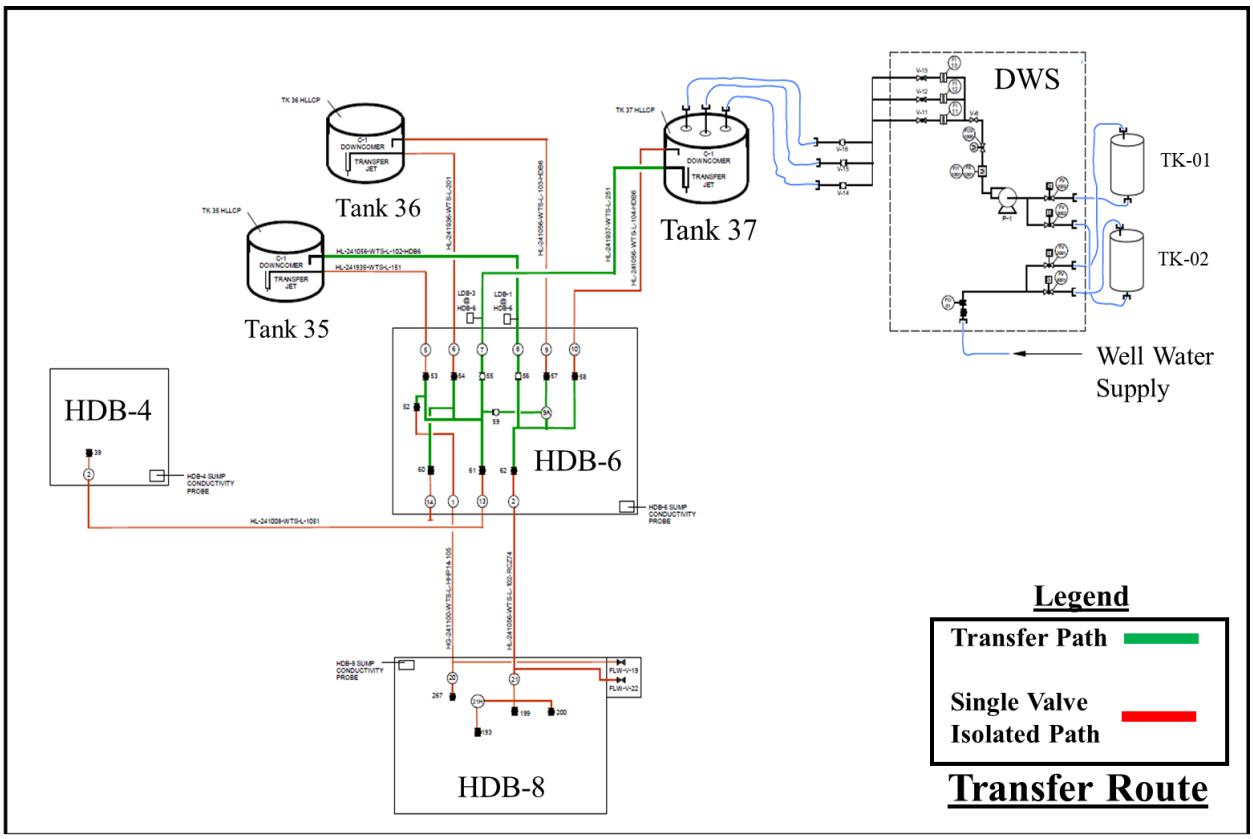

Fig. 2. Transfer Route Diagram Example [6]

Figure 2 shows a transfer between Tank 37 and Tank 35 that was used recently for salt dissolution activities. The pathway of the transfer is identified by the green lines and shows Tank 37 waste being transported out of the tank using a jet, passing through HDB-6, and entering Tank 35 through a downcomer. Also shown on the TRD are red lines, which show transfer pathways with only single valve separation from the transfer route. These red transfer lines are noted as monitoring downstream of the first closed isolation valve up to the second closed isolation valve to ensure the transfer continues along the intended path.

There are typically two or three diagrams for a TRD, which show the different configurations and equipment used as the transfer sections progress. The transfer path, flush, vent and drain, and pump tank transfers will have individual diagrams to show how these different activities will be performed throughout the transfer. Once the TRD is agreed upon, the procedure can start being developed.

Procedure Development

The itinerary for the trip is the transfer procedure. All the information gathered in the scoping meeting is used by the procedure group to write the transfer procedure, which describes every action taken from pre-start to post-transfer shutdown. The organization of the procedure is as follows: precautions and limitations, prerequisite actions, transfer, shutdown, and flush. At the beginning of each section the applicable administrative controls are called out to show they are satisfied within the section. At the end of the procedure, system checklists and data sheets are added for filling out during completion of the transfer. The data sheets are used to track the amount of material being transferred and if there is missing

waste. Missing waste is indicative of a leak in the system or valve misalignment. In which case, the transfer path is secured for leak investigation.

Before the journey begins, operations need to know two things: what is needed and what is expected. The Precautions and Limitations section is a list of items that explain the proper protections and actions needed to make the transfer safe. It also warns operations of conditions that warrant transfer shutdown. The Precautions and Limitations allow operations to go into the procedure feeling prepared and confident in the safety of the activity.

Prerequisite actions prepare the system for the transfer by verifying conditions and pathway alignment. All valves that require leak-checking are confirmed by actions in this section to avoid unintended transfer of waste. The prerequisite actions also verify critical transfer instrumentation used for tracking the material is working properly. Operator prestart aligns the transfer path and ensures pump speeds are set appropriately. Once the prerequisite actions and operator prestart are complete, everything is packed and ready for the trip to commence.

The transfer section begins with a start-up portion to activate the pump or jet and manipulate the final valves necessary to begin the transfer of materials towards the destination. The transfer section verifies the waste is reaching the correct location and prompts the operator to track system parameters for flow rates and levels. The transfer then continues with minor tweaks to maintain a steady rate of flow. Once the transfer is deemed complete, usually by reaching a transfer volume or waste tank level indicated in the ETAF, shutdown begins. Transfer shutdown stops the motive force before venting and draining the lines to a pre-determined location, such as a pump tank or one of the waste tanks. If a flush is required by the ETAF, the transfer lines will be flushed before the transfer procedure is declared finished.

The procedure group uses these general sections, with details based on the information from the scoping meeting, to create a draft specific to the transfer being performed. Once the draft is complete it undergoes a series of organization-wide reviews to determine the safety impacts from multiple perspectives. Included in this review process are groups such as: procedure writers, transfer engineering, environmental and waste characterization, waste management, operations, and radiological control operations. These groups work with the procedure writers by offering comments for incorporation during their review. The review and comment incorporation step is iterated until all concerns are resolved and the procedure is then approved.

After the review and approval of the transfer procedure, transfer engineers begin evaluating the transfer for potential hazards. This step is known as the Unreviewed Safety Question (USQ).

Unreviewed Safety Question (USQ)

The USQ screen ensures that the transfer procedure implements all DSA and TSR requirements and performance of the procedure as written is within the bounds of the DSA and TSRs.

One of the major concerns for transfer in the tank farms is the potential for siphons to occur. The siphons represent an unwanted detour for the waste, which can transport material to unintended locations. Depending on the transfer, there can be drastic elevation changes between the sending tank pump suction height, entry and exit locations of the transfer structures, and outlet location of the receipt tank. Due to these elevation differences, siphon potential must be inspected. To perform a siphon evaluation, the transfer path and components along the path are first defined. The elevations of the path components are obtained from reference drawings and a sketch is developed to show the transfer path elevation. The waste tanks are analyzed at their DSA fill limits for the siphon potential review. The sketch is then used to

evaluate siphon potential. If a siphon potential is identified, equipment that can be used to stop (generally, closing a valve along the transfer path) and ultimately break the siphon are located. An example of the siphon sketch can be seen below in Figure 3.

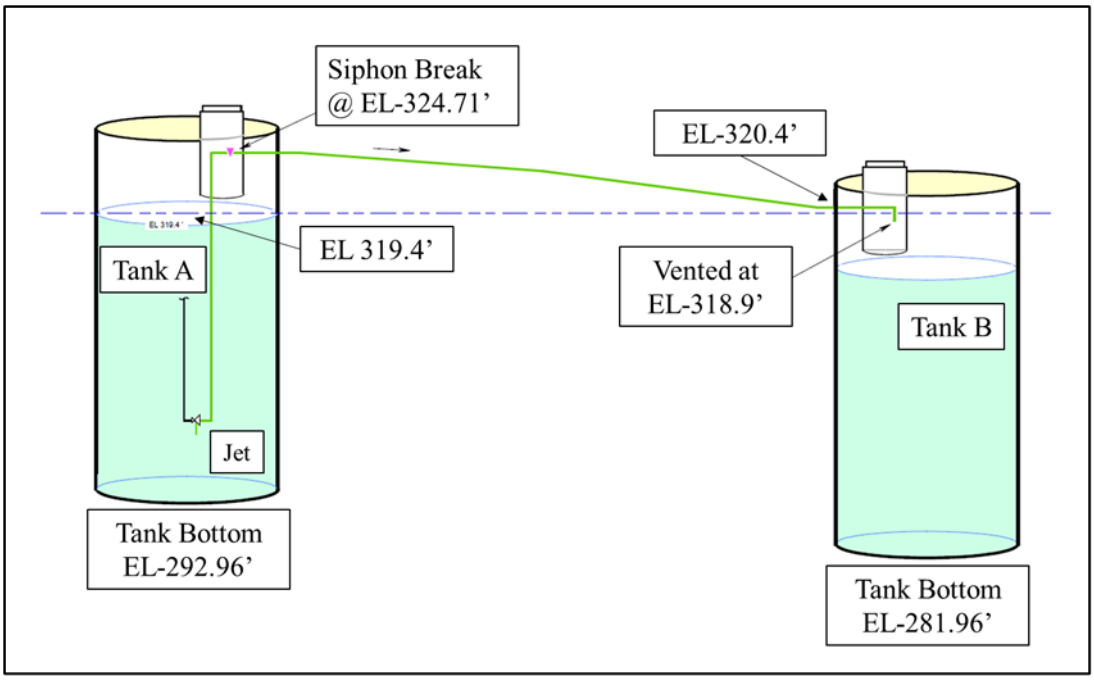

Fig. 3. Example of Siphon Potential Sketch [7]

Another important evaluation included in the USQ is limiting the pump speed to stay below the design pressure for the transfer lines and flow limit rates. If the design pressure of the transfer lines is exceeded the lines can be damaged to the point of leaks or even ruptures. Limiting the rotations per minute (RPMs) for the transfer pump places a speed limit on the waste and protects the integrity of the lines. In this case, the law enforcement protecting this limit is a Variable Frequency Drive (VFD). The VFD has the RPM limit programmed and then verified by a challenge test, so the system pressure will not exceed the design pressure of the transfer lines and the transfer flow rate will not exceed flow rate limits.

One of the concerns when performing transfers, especially in the case of transfers out of salt tanks, is the potential for salt-out. Salt-out is the process by which dissolved salt solution is heated during the transfer, usually when using steam jets, and, upon transfer completion, the cooling of the residual waste in the lines causes salt to precipitate out. These leftover salt precipitates can cause blockages and be a major issue for the next transfer through the line. If there is potential for salt-out to occur from the transfer, a flush of the transfer line is required post-transfer. These flushes are normally accomplished using water directly from the flush water system or a flush from a pump pit on the transfer path.

Another concern during transfers is water hammer, which can prove detrimental to critical equipment in the tank farms. Water hammer occurs when lines are not properly drained and vented or valves are manipulated too quickly, causing abrupt pressure changes capable of damaging the equipment. These situations can be related to unexpected stoppages in areas of high traffic flow resulting in wrecks. These accidents can be prevented by paying attention and looking ahead. For transfers, water hammer is evaluated by analyzing the topography and number of intermediate high and low points on the route to determine where the risk has the potential to be developed [8]. However, as long as equipment is

manipulated properly and the transfer lines are vented and drained correctly, the risk of water hammer can be avoided entirely.

Transfer Execution

After the procedure is reviewed, approved, and a USQ has been completed, the itinerary for the transfer is complete. The procedure is uploaded to the document database, Engineering Plant & Facilities Management (EPFM) for operations to begin preparations. The trip is nearly ready to commence, all that is left is a reservation. Due to the inherent chemical and radiological characteristics of the waste, an evaluation must be performed before the transfer can take place. The ETAF verifies the transfer details adhere to all applicable chemical and radiological operating limits and controls.

Operations then use the procedure to complete the transfer execution in the field, with oversight from the Control Room Operator (CRO) and Shift Technical Engineer (STE). The transfer is tracked using instrumentation connected to a Distributed Control System (DCS) and other indications in the field and/or control rooms. During travel, the driver tracks speed, fuel levels, and mileage using the instrumentation on the dashboard. For transfers, the transfer is tracked with pressure gauges, flow meters, and level indicators. If complications arise during the activity the transfer is placed into a safe system alignment for further decisions on completion or shutdown. However, if there are no issues the transfer is performed until the specific transfer volume or waste tank level is reached as stated in the ETAF. The transfer is then shutdown per the procedure and logged into the Electronic Material Balance (EMB) for reference.

CONCLUSIONS

Transfer engineers are vital to the operations being performed in the Tank Farms at SRS, playing major roles in each step of the journey. The Transfer Control PDD is the documented approach for safe transfers and explains the implementation of requirements laid out in the DSA and TSRs. Transfer engineers share their expertise in this document during the planning phase to help derive the TRD as a map of the transfer. The information they share is then used as the procedure writers create the itinerary for the trip, the transfer procedure. Once the itinerary is developed, transfer engineers aid in the review of the procedure to ensure adherence to all safety requirements and complete a USQ review to ensure compliance with DSA and TSR requirements. The journey is set once the procedure is approved and the ETAF reserves the transfer a date for the trip. Transfer engineers then shift their role to technical support to continue their work on the activity. During the transfer execution, transfer engineers remain on standby as engineering support for any setbacks that may occur during the trip. Transfer engineers complete this rigorous process for every new transfer in the Tank Farm to guarantee the safety of everyone. Every waste transfer completed helps to progress towards the goal of eliminating the risk to the public and environment from the waste held in aging waste tanks.

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