Addressing an Aging Facility: Improving Reliability of the Defense Waste Processing Facility at the Savannah River Site - 15539

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ABSTRACT

The High Level Waste program at the Savannah River Site significantly reduces environmental risks associated with the storage of radioactive waste from legacy efforts to separate fissionable nuclear material from irradiated targets and fuels. The Defense Waste Processing Facility treats and immobilizes High Level Waste into a durable borosilicate glass for safe, permanent storage. Construction of the facility began in 1983 and radioactive operations commenced in 1996. In an effort to support the disposition of radioactive waste and accelerate tank closure for the balance of the Savannah River Site mission, the Defense Waste Processing Facility recently underwent an extensive reliability review in 2013 to understand future needs as well as to address aging infrastructure. As a product of this review, a Performance Improvement Plan was developed to systematically address three major focus areas including, a) asset preservation, b) facility housekeeping, and 3) process improvements. Since issuance of the plan, significant progress has been made in each of these areas to improve the reliability and predictability of the Defense Waste Processing Facility.

INTRODUCTION

Liquid Waste Operations at the Savannah River Site

Since becoming operational in 1951, the Savannah River Site has produced nuclear material supporting a number of national interests including defense, research, medical, and space programs. These activities resulted in the generation of large quantities of radioactive waste that are currently stored in large underground waste storage tanks. Continued long-term storage of these radioactive wastes poses a potential environmental risk. Thus, the focus of the Liquid Waste Organization of the Savannah River Site is to safely store, remove, treat, and disposition legacy radioactive waste in an effort to significantly reduce this environmental risk.

The waste inventory currently stored at the Savannah River Site is a complex mixture of insoluble metal hydroxide solids and soluble salt supernate. The insoluble solids component of the radioactive waste represents a small portion of the overall volume of radioactive waste on site (approximately 8%), but represents almost 50% of the total curies [1]. By contrast, the soluble salt supernate (present in the form of salt supernate and concentrated crystalline saltcake) represents an overwhelmingly large portion of the overall volume of radioactive waste on site (approximately 92%), and an equal portion of the total curies [1]. The insoluble solids are treated at the Defense Waste Processing Facility via vitrification, stabilizing the High Level Waste in a final borosilicate glass waste form. The soluble salt waste is treated to remove the radionuclides from the non-radioactive salts in the waste and then sent to the Saltstone Facility, which disposes of the Low Level Waste in a cementitious waste form. The High and Low Level Waste programs are not mutually exclusive, but require careful integration and planning to successfully achieve tank closure. Thus, the success of both the High Level Waste and Low Level Waste programs at the Savannah River Site are critical to reducing environmental risk at the Savannah River Site. An overview of the Liquid Waste Operations is provided in Figure 1.

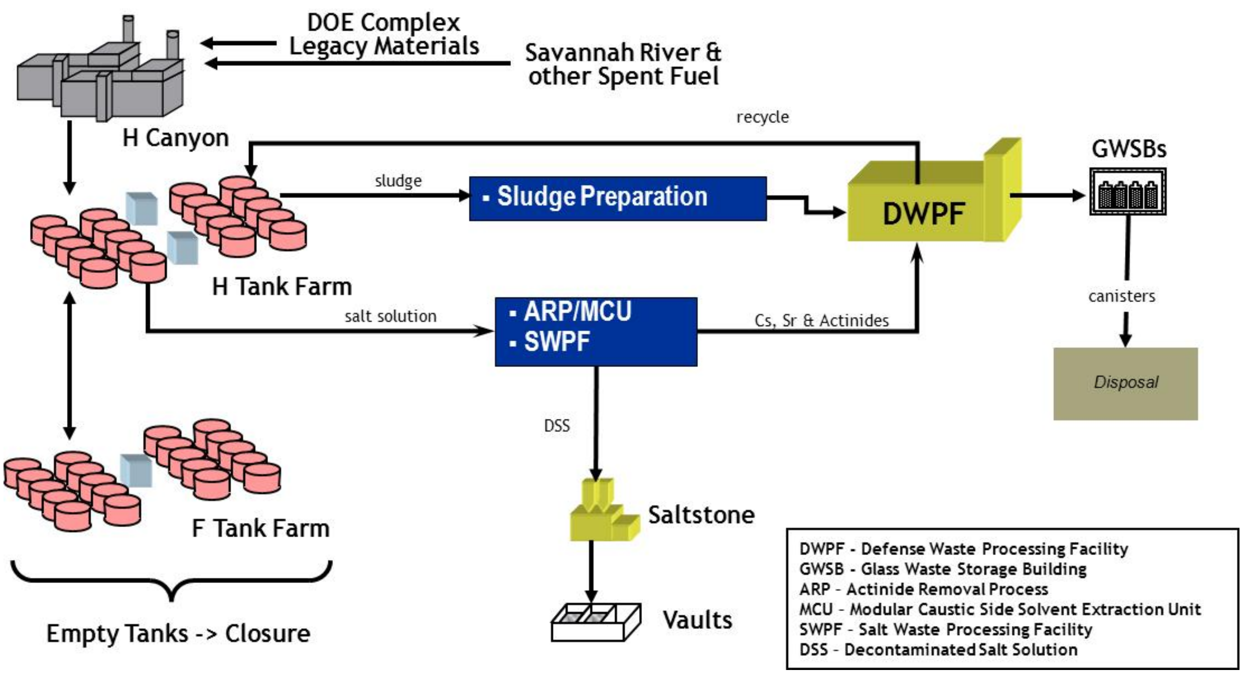

Fig. 1. Overview encompassing the High and Low Level Waste programs of the Liquid Waste Organization at the Savannah River Site.

High Level Waste Program

Final processing of High Level Waste generated from the production of nuclear material at the Savannah River Site since the 1950s (approximately 136 million liters) occurs at the Defense Waste Processing Facility by first treating the waste via a complex sequence of controlled chemical reactions, followed by blending the treated waste with glass formers. The blended waste is then vitrified into a borosilicate glass form, and the resulting molten glass poured into stainless steel canisters.

Nominally, 22,500 liters of sludge is received on a batch basis in the Sludge Receipt and Adjustment Tank from a 3.7 million liter feed tank. The sludge is chemically adjusted in the Sludge Receipt and Adjustment Tank via addition of concentrated nitric and formic acids. The purpose of the chemical adjustment is to acidify the incoming sludge to adjust the rheological properties to improve processing, remove mercury from the sludge feed, and to prepare the sludge feed for melter operation by controlling the reduction/oxidation state of the glass. The Sludge Receipt and Adjustment Tank also receives and processes by-products from salt processing, namely an actinide-rich stream containing primarily monosodium titanate solids as well as a cesium-rich dilute nitric stream (see Figure 1). Following chemical adjustment and concentration in the Sludge Receipt and Adjustment Tank, the sludge material is transferred to the Slurry Mix Evaporator where the material is blended with frit (glass former). The Slurry Mix Evaporator represents a hold point in the process to ensure the contents will produce acceptable glass (based on statistical process control rather than statistical quality control). Upon confirmation that the blended Slurry Mix Evaporator material is acceptable, the material is transferred to the Melter Feed Tank, which represents a transition in the process from a batch to continuous process, as the Melter Feed Tank continuously feeds the melter. During normal operation, the melter constantly receives a small stream of slurry from the MFT (nominally 3.8 liters per minute) and melts the feed through the use of an electric current which is passed through the melt pool by two sets of electrodes, resulting in heat-up of the melter feed (i.e. Joule heating). Molten glass from the melt pool is then transferred into stainless steel canisters for permanent immobilization. An overview of the Defense Waste Processing Facility is provided in Figure 2.

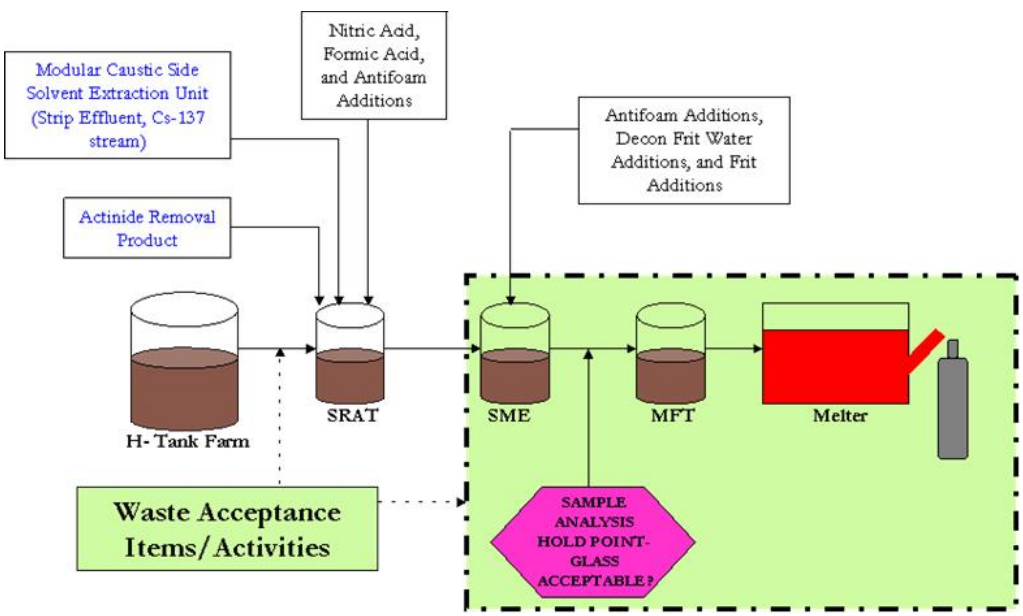

Fig. 2. Schematic providing an overview of the current Defense Waste Processing Facility flowsheet.

Since commencing operations in 1996, the Defense Waste Processing Facility has produced more than 6.8 million kilograms (15 million pounds) of vitrified hazardous stabilized waste in 3,877 canister as of September 30, 2014. In addition, the Defense Waste Processing Facility has successfully accommodated receipt of by-products from salt waste processing since 2007.

DISCUSSION

Reliability Review

The DWPF has demonstrated consistent production performance over the course of its operating life, including establishing a new production record (over a 12 month period of performance) in fiscal year 2012 (FY12). However, in late 2012, the facility began to experience compounding issues which negatively impacted production performance. In January 2013, SRR assembled an expert review team in an attempt to further alleviate some of the production issues. This review team was comprised of independent personnel from Savannah River Remediation, URS Corporation, AREVA, the Savannah River National Laboratory, Energy Solutions, the Hanford Waste Treatment Plant, Sellafield (Nuclear Management Partners, Ltd.), and selected independent reviewers with significant vitrification, engineering, operations, and maintenance experience. The scope of the review was to:

"…understand what was impacting the facility immediately and what the long term potential impacts were associated with future needs, aging facility, and baseline management…"

Based upon a comprehensive review, key recommendations were provided for consideration by the facility. Many of these recommendations complemented the on-going initiatives within the facility. Recommendations included flowsheet improvements, addressed maintenance and housekeeping issues, work planning, and gaps within the system health program.

The multitude of initiatives and recommendations aimed at addressing current (as well as the balance of the life cycle) issues established the need for a process to assess performance feedback and implement prioritized actions to improve both short-term and long-term production performance in order to best leverage available resources. To address this need, a DWPF Steering Team was assembled with the goal of producing an integrated Performance Improvement Plan (PIP) for the DWPF. In the following sections, the methodology utilized to organize and prioritize the various assessments is presented along with results from implementation of this technique. This is followed by a discussion of the integrated plan for addressing both short-term and long-term production performance improvements.

Performance Improvement Plan Development

Initially, the goal of the DWPF Steering Team was to develop a process to effectively assess performance feedback from a variety of sources covering a comprehensive scope. Recognizing the complexity of the assessment along with the importance of expediently implementing short-term actions, the team aimed for the development of a simple and efficient tool to prioritize and affinitize recommendations. To maximize use of existing resources and tools, the team utilized an architecture which leveraged (when possible) existing organization structures and processes. The result is the Organization and Prioritization Technique for Continuous Success (OPTiCS), shown in Figure 3.

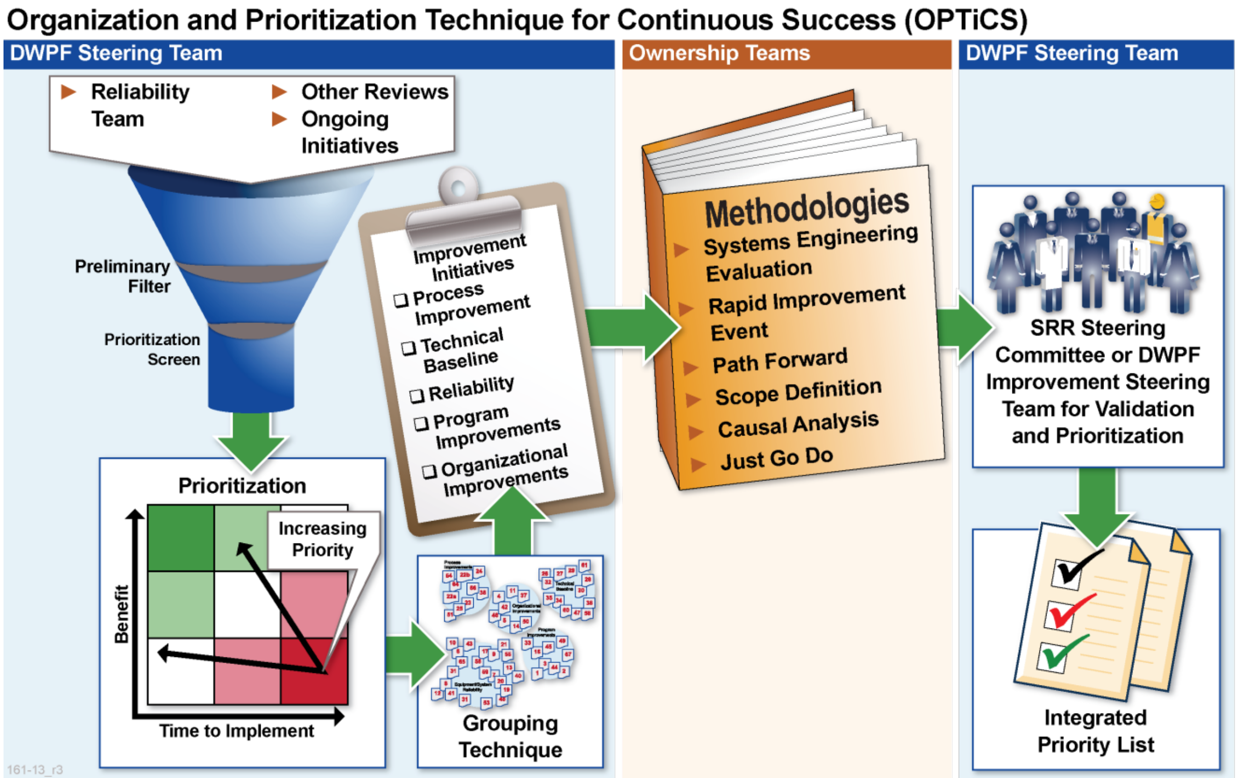

Fig. 3. Organization and Prioritization Technique for Continuous Success (OPTiCS)

The technique works by the following process:

1) Identify and collect data
2) Screen data for immediate actions
3) Analyze and prioritize data
4) Determining major groupings
5) Action planning
6) Planning and integration

Steps 1-4 were performed by the DWPF Steering Team. For steps 5 and 6 of the process, Ownership Teams were established. The Ownership Teams are tasked to further refine and evaluate specific source data within each Improvement Initiative. The function of the Ownership Teams is to develop detailed Action Plans within each Improvement Initiative as well as to involve facility personnel directly in determining the solutions that are to be implemented. A standard planning and evaluation process was established to help ensure each improvement effort, regardless of the stage of progress, is evaluated by Ownership Teams on a priority basis. This process is uniquely designed to ensure improvement efforts are deployed based on priority ranking and on improvement value contribution. Owing to the variation in maturity of each of the Ownership Teams, multiple methodologies may be utilized to develop detailed Action Plans. A key point to note is that the Ownership Teams were not limited to planning and execution related to Reliability Team recommendations, but are permitted to utilize brainstorming techniques (e.g. problem statement development, causal analysis) to properly develop Action Plans, where applicable. In some cases, the improvement efforts are cross-cutting and rise to a level that will be addressed at the SRR senior management level.

This process was utilized to organize and prioritize 63 key recommendations from the Review Team. Recommendations were condensed into over-arching categories shown. The grouping of Improvement Initiatives encompassed most, if not all, key aspects of safe nuclear operation. The five major Improvement Initiatives identified utilizing this technique were:

- Process Improvements,
- Equipment/System Reliability,
- Technical Baseline,
- Organizational Improvements, and
- Program Improvements.

	Short Term	**Long Term**
DWPF Steering Team	• Critical Canyon Equipment • Canyon Vessel Purge Modification • Melter Off-Gas Flammability	• Pump Reliability • Alternate Reductant Project • Dry Process Frit • SEFT to SME Modification • DWPF Evaporator • Process Optimization
SRR Senior Steering Committee	• System Health Improvements • Salt Integrated Project Team	• Procurement Supply Chain Improvement • Asset Preservation • Knowledge Capture/Retention • Maintenance Programs

Fig. 4 Ownership teams and performance monitoring responsibility

Fifteen Ownership teams were formulated, on a priority basis, with knowledgeable individuals to evaluate the Review Team recommendations, along with other inputs and the free-flowing ideas of the teams with the intent of developing the most value-added actions to address the two strategic objectives. The ownership teams identified were outlined with a scope description and primary performance objective. For those cross-cutting or company level teams, the SRR Senior Steering Committee has the responsibility to establish the team makeup and objectives.

The teams are identified and categorized based on which steering team is assigned to monitor and by whether they are short term or long term to implement and shown in Figure 4.

Facility Achievements

A significant number of items to improve performance of DWPF have been initiated and completed. These items were identified by the facility during various initiatives such as: internal and external review teams, brainstorming sessions, issue evaluations, engineering path-forwards, and management field observations. Asset preservation efforts have been initiated to identify critical equipment and appropriately allocate monies for replacements and spares. These efforts have reduced facility liability based upon chronic equipment obsolescence, and strengthened the critical link between production performance and life-cycle asset planning. Critical spare equipment has been identified and procured, which significantly reduces facility vulnerabilities. In addition to asset preservation, the facility has undertaken a tremendous housekeeping effort aimed primarily at improvements to decontamination systems as well as clean-up and decontamination of legacy equipment waste. These efforts allow for more effective response to refurbishing critical canyon equipment and improve canyon accessibility through failed equipment size reduction and removal. Another key aspect pursued is a reduction in the maintenance backlog, which has further improved the condition of equipment in the facility. Lastly, significant process improvements are underway to implement process enhancements aimed at addressing future demands on the facility, including new processes as well as higher throughput. Additionally, significant progress has been made to gain a better understanding of flowsheet limitations, and to devise operating strategies (or improvements) to ensure these limitations are not challenged.

The final result is improved performance in DWPF that resulted inthe increased production rate compared to the average throughput achieved in early 2012. The increasing production rates can be clearly seen in Figure 5, which shows monthly production numbers as an annual rate. The actions completed also allowed the facility to set a new monthly production record of 40 canisters produced in August of 2013.

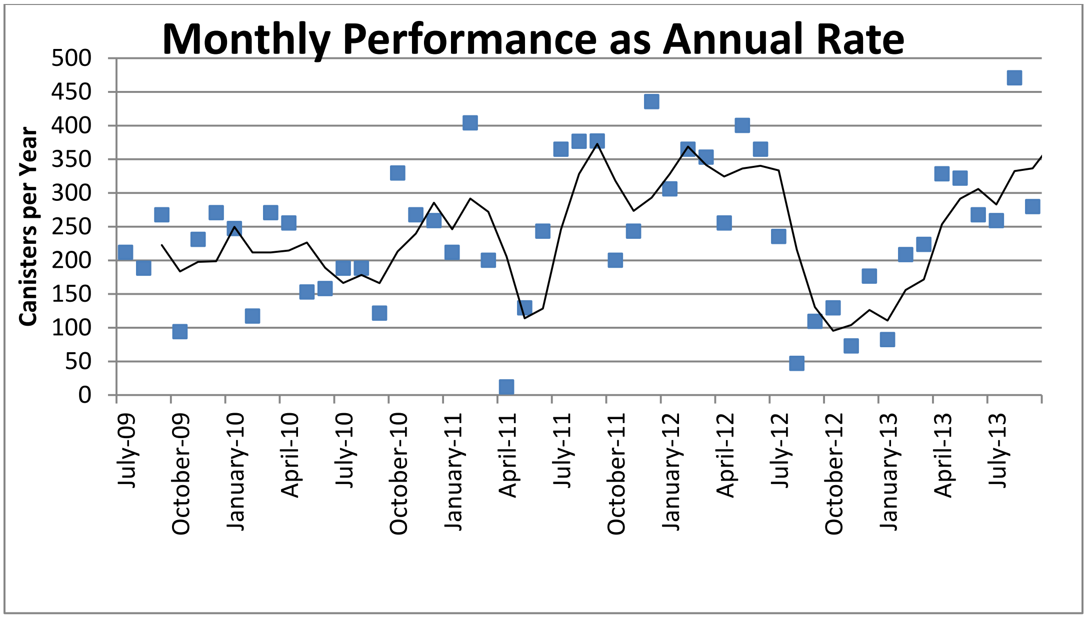

Fig. 5 Results of the actions implemented in February 2013 thru September 2013. The trendline is a three month rolling average for production.

CONCLUSIONS

The Defense Waste Processing Facility commenced radioactive operations in 1996, and is expected to continue to operate at capacity through the Liquid Waste mission, which is currently projected to complete in 2032. To address issues related to an aging facility, a review team was commissioned to evaluate current practices and to identify improvement opportunities to ensure sustainable production at the Defense Waste Processing Facility. Recommendations were identified in key areas such as a) asset preservation, b) facility housekeeping, and 3) process improvements. Since issuance of the plan, significant progress has been made in each of these areas to improve the reliability and predictability of the Defense Waste Processing Facility.