DOE-EM Technical Strategies for Transforming the Tank Waste System—10156

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ABSTRACT

Tank waste poses the most significant environmental, safety and health threat in the Department of Energy (DOE), and management of tank waste comprises the largest cost element for the Office of Environmental Management (EM). Given the large risk and cost of the tank waste program, EM chartered the Tank Waste System Integrated Project Team (IPT) to recommend strategies that could transform the tank waste system into a vastly more efficient and cost-effective system. The IPT identified twelve site-specific technical process strategies, six each at DOE's Hanford and Savannah River sites, with potential to optimize the tank waste systems. The strategies include technical changes to optimize planned waste processing operations or to provide new system capabilities to reduce life-cycle schedule and costs. Further, the IPT developed seven cross-cutting transformational technical recommendations. Implementing all of the recommendations will transform the tank waste systems at the Hanford and Savannah River sites such that the existing cumulative life-cycle baseline cost could be reduced by more than one third.

INTRODUCTION

There are currently almost 90 million gallons of waste being safely stored in 230 tanks at DOE's Hanford, Savannah River, and Idaho sites. Tank waste in DOE's two largest tank waste systems, Hanford and Savannah River, resulted from the Cold-War defense mission of producing the man-made material plutonium (Pu) for nuclear weapons. Uranium (U) was put into a reactor to produce Pu; the Pu and U were extracted; and the rest of the material resulting from the process was considered waste and placed in huge underground tanks for eventual treatment and disposal.

Tank waste poses the most significant environmental, safety and health threat in the Department of Energy (DOE), and management of tank waste comprises the largest cost element for the Office of Environmental Management (EM). Given the large risk and cost of the tank waste program, in March 2009 EM chartered the Tank Waste System Integrated Project Team (IPT) to develop alternative technical strategies and transformational solutions that could result in an improved, optimized, and less costly tank waste system. The IPT evaluated the tank waste systems at DOE's two largest waste sites, Hanford and Savannah River. The results of this evaluation are intended for planning and analysis purposes, assuming a continuing constrained budget environment. Every effort will be made to comply with all applicable environmental and legal obligations, while also assuring that essential functions necessary to protect human health, the environment and national security are maintained.

The IPT met with DOE and contractor staff at the sites and at headquarters, obtained advice from the Tank Waste Corporate Board, consulted with other technical and corporate review teams, and reviewed many documents to identify technical strategies. The IPT's final report entitled *Technical Evaluation of Strategies for Transforming the Tank Waste System* was published in January 2010 and consists of two volumes: Volume 1 contains a summary and recommendations, and Volume 2 presents a detailed analysis of the strategies. [1]

TECHNICAL RECOMMENDATIONS

The IPT developed technical strategies for each site, evaluated those strategies for the overall tank waste system, and then proposed seven transformational technical recommendations. The seven transformational technical recommendations are

TR-1 At-Tank/Near-Tank Processing – This strategy provides supplemental treatment capability at or near the waste storage tank. Modular equipment is used to allow solids and radiochemicals to be removed, speeding processing rate and allowing early operation of low-activity waste systems. This strategy will reduce the overall time to treat wastes at Hanford and Savannah River.

TR-2 Glass Optimization (including Next-generation Melters and Waste Loading Enhancements) – This strategy will increase waste loading and improve related processes at both Hanford and Savannah River and will develop and deploy next-generation melters at Hanford. Results of this strategy include the reduction in the number of canisters and in overall processing time.

TR-3 Advanced Separation Processes – This strategy provides new separation processes to separate low-activity waste from the tank waste to minimize the volume of high-activity waste. Implementation of aluminum and caustic management to reduce the volume of high-activity waste to be treated is a key cost driver for both sites.

TR-4 Alternative Treatment/Disposal Processes – This strategy will develop and deploy alternative treatment processes, such as steam reforming and evaporation followed by sodium silicate solidification. The volume of waste that must be processed at existing waste treatment facilities will be reduced, cutting the overall plant utilization and schedule at both sites.

TR-5 Waste Staging/Area Closure – This strategy will consolidate waste to improve feed to treatment facilities and allow whole tank farms to be closed at both sites.

TR-6 Mixing/Blending Systems Optimization – This strategy will provide optimized mixing and blending operations at Hanford to minimize glass waste volume by careful selection and mixing of compatible tank wastes.

TR-7 Integrated Systems Analysis – This strategy will continue work on the development of tools to assist in performing integrated systems analysis. In particular, multiple attributes of the tank waste systems should be evaluated together to determine whether additional transformational changes can be made.

The technical recommendations require technology development to be successful. This includes maturation of at-tank treatment, retrieval, and volume reduction technologies and development of technologies for aluminum leaching, tank mixing, and next-generation melters. This is consistent with recent National Academy of Sciences recommendations [4].

The implementation timeframe for these recommendations has been divided into three groups: Near-term (less than 5 years), Mid-term (5 years to 15 years), and Long-Term (greater than 15 years). All of the process strategies are in the mid-term range, except for the implementation of next-generation melters which is in the long-term range.

Implementing all of the technical recommendations will transform the tank waste systems at the Hanford and Savannah River sites such that the existing cumulative life-cycle cost could be reduced by more than one third. The cost savings result from changes to the tank waste system that include treating waste in modular treatment facilities at the waste tank that supplements existing treatment capacity; optimizing the processes to minimize the amount of HLW and LAW glass produced; and providing alternative approaches for treating and disposing LLW. These changes to the system result in reducing the size or eliminating the need for constructing major new treatment facilities, reducing the operating period for existing treatment facilities, and reducing the number of HLW canisters produced by as much as one third.

TANK WASTE SYSTEM CURRENT STRATEGIES

The current strategy for mitigating the risks posed by the waste stored in these tanks includes the following basic components: (1) removing the waste to the maximum extent practical, particularly from older single-shell tanks; (2) separating the waste into low- and high-activity wastes and immobilizing those wastes on-site in large treatment facilities; (3) closing the tanks according to compliance agreements; (4) conducting engineering and applied research, development, and deployment to resolve unique and complex clean-up challenges; (5) disposing of low-activity waste on-site and storing high-activity glass waste canisters on-site until an off-site repository is available; and (6) disposing of high-level waste (HLW) in an off-site repository.

The Hanford tank waste system is managed by the River Protection Project (RPP). The current processing steps at the Hanford RPP are shown in Figure 1. The wastes from the single-shell tanks (SSTs) are retrieved and consolidated into the double-shell tanks (DSTs). The liquid waste contains radioactive constituents (e.g., cesium and strontium) but does not contain the insoluble transuranic materials. This liquid waste is processed to remove the radionuclides, and the remaining liquid is then fed to the Low-Activity Waste (LAW) treatment facility, where the waste is converted into a bulk glass to be disposed of on-site in shallow land burial. The sludge containing the highly radioactive constituents is recovered from the DSTs and fed to the Waste Treatment Plant (WTP), where the sludge is washed to remove nonradioactive constituents (e.g. aluminum, sodium, iron) to reduce the waste volume. These nonradioactive constituents are blended with the tank liquid and fed to the LAW facility. The remaining HLW constituents are blended with the radioactive components removed from the liquid and fed to the HLW vitrification facility, where the HLW glass is produced and placed in canisters for on-site storage and eventual shipment to a permanent repository. The emptied tanks and equipment for processing will be closed and disposed of after the operation is complete. [2]

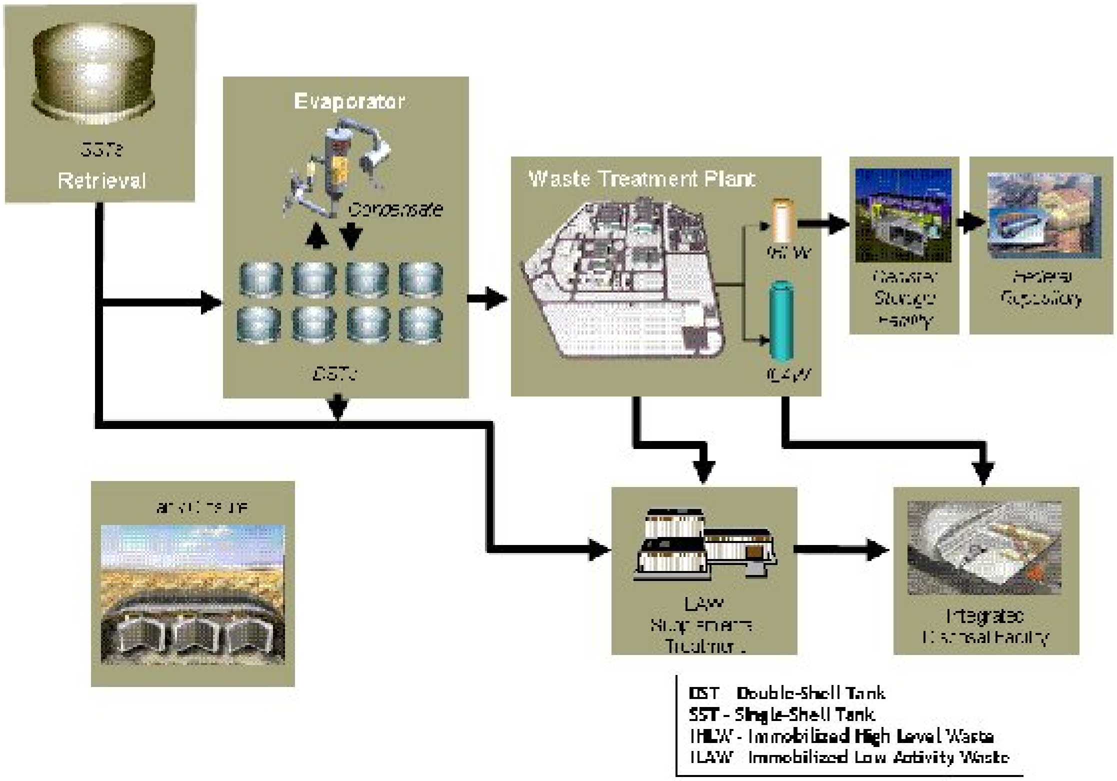

Fig. 1. Hanford Flow Sheet

A similar flow sheet is used at Savannah River, as shown in Figure 2. As at Hanford, tank waste is separated into low-level and high-level radioactive components, which are treated separately. The liquid salt solution is treated to remove radioactive elements, and then the residual low-level waste is stabilized in a special grout known as saltstone. The sludge is removed from the tanks by sluicing, then washed and leached to remove the non-radioactive constituents such as sodium, aluminum, and iron, which after salt processing are sent to the Saltstone Facility. The remaining highly radioactive sludge is sent to the Defense Waste Processing Facility, a high-level waste vitrification facility in operation since 1996, to produce the final product. The canisters containing waste vitrified in a special glass formulation are then stored at the site for eventual shipment to a permanent repository. Savannah River is over one third complete in the processing of SRS tank wastes. [3]

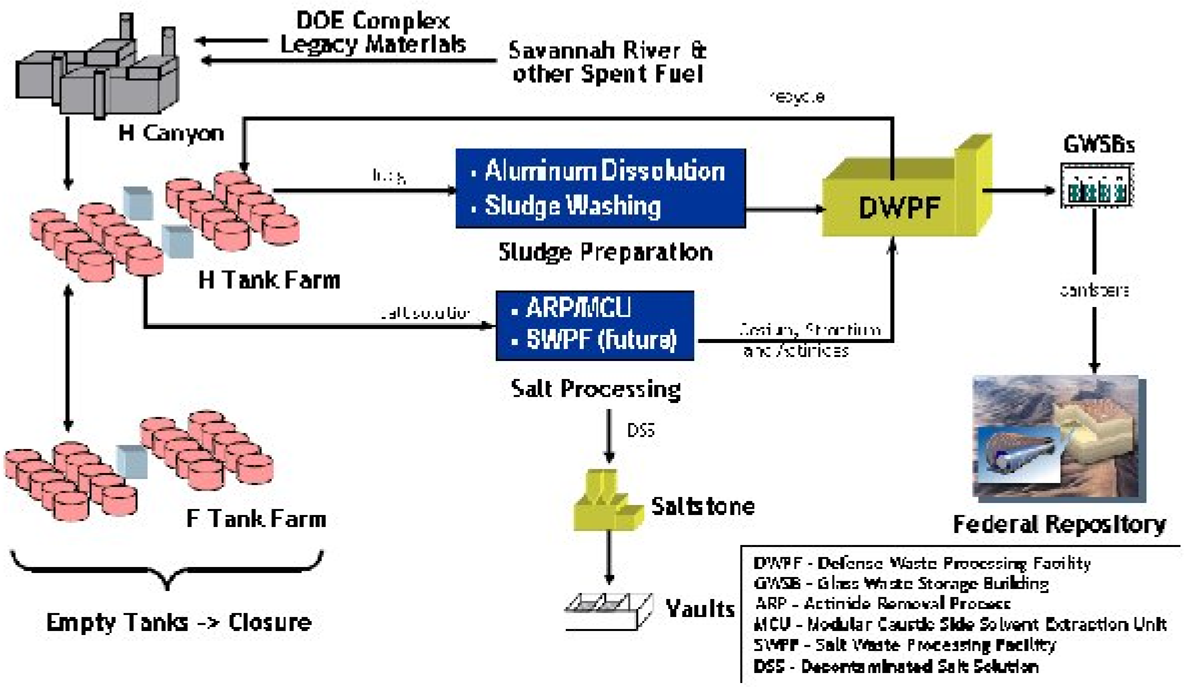

Fig. 2. Savannah River Site Flow Sheet

TECHNICAL STRATEGIES

The twelve site-specific technical process strategies, six each at Hanford and Savannah River, have the potential to optimize the tank waste systems. These strategies optimize planned waste processing operations or provide new system capabilities that can reduce life-cycle costs.

Hanford RPP technical process strategies are

RPP-1 At-Tank Treatment – This strategy provides supplemental treatment capability at the waste storage tank. At-tank waste processing provides a method of augmenting planned treatment capacity without construction of major new facilities.

RPP-2 Sodium and Aluminum Management – This strategy provides optimized sodium and aluminum processing operations. Removing aluminum prior to treatment without adding large quantities of sodium will reduce treatment facility operations time.

RPP-3 Mixing and Blending Systems Optimization – This strategy provides optimized mixing and blending operations resulting in consistent feed batches to the treatment facilities, reduced sampling, reduced glass formulations, and ultimately reduced number of waste canisters.

RPP-4 Glass Optimization – This strategy provides improved waste form performance, waste loading, melt rates, and melters. Improving these system attributes will optimize treatment facility operations.

RPP-5 Waste Staging and Area Closure – This strategy provides for the transfer of waste stored in SSTs to selected sound SSTs and double-shell tanks (DSTs). This will allow early tank farm area closures.

RPP-6 Alternative On-site Disposal of Low-Level Waste – This strategy identifies means other than through the WTP LAW facility to dispose of low-level waste (LLW) on-site.

The Savannah River technical process strategies are

SR-1 Increase Salt Processing Rate – This strategy increases the rate at which salt waste is processed through extended near-term use of an existing process and long-term use of a supplemental at-tank modular salt process. This supplemental treatment capability will augment planned treatment capacity without construction of major new facilities.

SR-2 Reduce Complexity of Tank Cleaning and Closure – This strategy reduces the technical complexity of cleaning and closing waste tanks. This will optimize operations while still being protective of human health and the environment.

SR-3 Reduce Complexity of LLW Disposal – This strategy provides a process that reduces the LLW volume destined for the Saltstone Facility, which in turn will reduce the number of LLW disposal vaults needed for salt processing operations.

SR-4 Aluminum Management/Alternative On-site LLW Disposal – This strategy removes aluminum from certain sludge waste. The resulting low activity aluminum waste is then disposed on-site in LLW facilities. This alternative disposal method enables the removal of aluminum from sludge to continue.

SR-5 Glass Optimization – This strategy provides improved waste loading which will reduce the number of canisters produced. Improving this system attribute will optimize treatment facility operations.

SR-6 Place Saltstone Grout in Tanks During Closure – This strategy provides a capability for placing Saltstone grout into waste tanks instead of clean grout, thereby optimizing waste disposal and tank closure operations.

CONCLUSION

The work documented in *Technical Evaluation of Strategies for Transforming the Tank Waste System: Tank Waste System Integrated Project Team Final Report* represents the development of site-specific technical process strategies and cross-cutting transformational technical recommendations to improve the performance of EM tank waste systems and reduce life-cycle costs. The recommendations constitute one input to strategic decisions for managing the tank waste system. Examples of other decision variables include budget support and risks, stakeholder inputs, worker and public safety considerations, and operational needs. The results of this evaluation are intended for planning and analysis purposes, assuming a continuing constrained budget environment. Every effort will be made to comply with all applicable environmental and legal obligations, while also assuring that essential functions necessary to protect human health, the environment and national security are maintained.

All of the recommendations require technology development to be successful, but all of the recommendations are feasible and can be implemented. The cost savings from implementing the recommendations result from changes to the tank waste system that include treating waste in modular treatment facilities at the waste tank that supplements existing treatment capacity; optimizing the processes to minimize the amount of HLW and LAW glass produced; and providing alternative approaches for treating and disposing LLW. These changes to the system result in reducing the size or eliminating the need for constructing major new treatment facilities, reducing the operating period for existing treatment facilities, and reducing the number of HLW canisters produced by as much as one third.

In summary, the recommended suite of transformational strategies could reduce the existing cumulative life-cycle baseline cost of the tank waste systems at the Hanford and Savannah River sites by more than one third.

REFERENCES

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