Department of Energy Tank Closure – an Examination of Alternative Approaches

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ABSTRACT

Closure of single- and double-shell underground waste storage tanks at sites across the DOE complex poses a unique technical and regulatory challenge. Some sludge waste residues invariably remain in a tank after bulk waste retrieval, especially in tanks with piping or obstructions. Reducing the volume of the waste residues becomes increasingly difficult depending on the constituents and the age of the heel.

The use of a tank closure strategy that is informed by risk rather than subjective criteria may allow more efficient retrieval and characterization of the tank wastes.

Gaps in the technical bases supporting tank retrieval and closure have historically resulted in overly conservative assumptions in performance assessments. An alternate tank-closure approach would be to develop a scientific basis for tank closure, which may allow greater waste volumes to be left in the tanks post-retrieval while increasing protectiveness to human health and the environment. The approach is to characterize complex residual tank waste solids, measure contaminant release rates as a function of chemical environment, and build mechanistic release models.

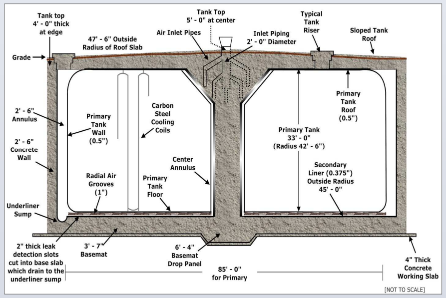

Figure 1. Typical SRS Type IIIA Waste Tank

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INTRODUCTION

Closure of the 230 remaining active underground waste storage tanks poses unique challenges at four sites across the DOE complex: the Savannah River Site (SRS), Idaho National Laboratory (INL), West Valley Demonstration Project (WVDP), and Hanford. This is, in part, because the natures of the wastes, composition and types of tanks, and regulatory regimes are different at the various sites. Despite the complexities, tank closure progress has been made.

TABLE I. Tank Closure Status

	Hanford	SRS	Idaho	West Valley
Total Number of Tanks	177	51	15	4
Closure in Progress	17	9	0	4
Grouted and Stabilized	0	6	11	0

APPROACHES AND TECHNOLOGIES FOR TANK WASTE CHARACTERIZATION, RETRIEVAL AND TANK CLEANING

Heel Retrieval – Mechanical Cleaning Approaches

DOE has adapted and successfully used a vacuum heel retrieval technology in the cleaning of unobstructed SRS Type IV tanks, Tanks 18 and 19. This technology used a cleaning device, called a Mantis, consisting of a mechanical crawler along with an ultra-high-pressure water eductor to vacuum residual solids and transports the slurry to a receipt tank.

Hanford has adapted a FoldTrack device, originally used for cleaning sludges in oil tankers, for use inside of unobstructed tanks. Similar in concept to the Mantis, the FoldTrack mechanically breaks up chunks of waste, moving solids to the pump inlet. The apparatus can collapse, i.e. fold to fit through tank risers. The Foldtrack has nozzles to spray high-pressure water directly at the waste. Hanford is also developing the Mobile Arm Retrieval System (MARS) to retrieve radioactive and chemical waste from underground single shell storage tanks. There are two retrieval mechanisms, the MARS-Sluicing (MARS-S) and the MARS-Vacuum (MARS-V). The MARS-S routes pressurized fluids through spray nozzles to loosen waste materials. The MARS-V minimizes the amount of liquid in the tank by directing pressurized fluids through an eductor nozzle while drawing a vacuum on the waste material. During testing, the MARS-V demonstrated the ability to remove sludge, small rocks, sand and the hard-packed waste from the bottom of some tanks.

Figure 2. Mantis Device

Figure 3. Hanford Foldtrack Device

Heel Retrieval – Chemical Cleaning Approaches

SRS has used two tank chemical cleaning technologies: Low Temperature Aluminum Dissolution (LTAD) and Bulk Oxalic Acid Cleaning (BOAC). A successful chemical cleaning strategy used the following processing sequence: LTAD, washing, BOAC, and neutralization. Although LTAD and BOAC chemical cleaning has been effective, no disposition path has been identified for oxalate added during BOAC. Insoluble oxalate salts are accumulating within the SRS tank farm and waste processing facilities. Extensive sludge washing is required to remove moderately soluble sodium oxalate salts prior to sludge vitrification in the DWPF. Consequently, oxalate additions to the tank farm need to be minimized by the use of supplementary acids or the use of other cleaning reagents or processing strategies.

Neither LTAD nor BOAC are highly effective at removing certain secondary metal components of HLW sludge; specifically, Hg, Ni, and Mn. If removal of these secondary components is required for tank closure, then methods need to be developed to solubilize these constituents. Because of the downstream challenges posed by BOAC, Hanford is moving away from this technique. Instead Hanford is using modified sluicing with tank supernate to mobilize and retrieve the residuals. The Hanford tank waste is more diverse than SRS waste due to the variety of different chemical processes that were used at Hanford. Retrieval of Hanford HLW tank heels may require alternative approaches.

Waste Characterization

Waste sampling and characterization is required to assess the chemical and radiological characteristics of the residual wastes and the fixed contamination left in the emptied tanks. Many of the analyses involve multiple cycles of radiochemical separations. In many cases, the time requirements for completion of the radionuclide analyses are several months, and the respective costs are commensurately high. To address these issues, the Department has initiated the Cost Effective Tank Waste Characterization project to optimize tank waste characterization. The goal is to implement programmatic changes that accelerate tank waste processing and tank closure schedules, while at the same time reduce characterization costs.

Figure 4. SRS Tank 19 Before Cleaning

Figure 5. SRS Tank 19 After Cleaning

ALTERNATIVE TANK CLOSURE OPPORTUNITIES

DOE experiences in closing tanks provide opportunities for improving our understanding of the risk and cost implications of retrieval and closure methods that can be applied to subsequent tank farm closures.

Gaps in the technical foundation and modelling supporting tank closure have resulted in a number of overly conservative assumptions in tank closure Performance Assessments (PA's).

Recent experimental results and new models on concrete performance and groundwater movement are improving the assumptions used in PA's and decreasing the uncertainties.

New capabilities being developed as part of the Advanced Simulation Capability for Environmental Management (ASCEM) Project are well suited for reducing the need for conservative assumptions in PA's.

Implementing risk-informed decision-making to tank closure requires an integrated laboratory and modelling program to develop a strong technical foundation. Requirements of a successful program include:

- Quantifying the long-term risk reduction benefits of varying degrees of tank retrieval and the differential effect of alternative retrieval methods and end points (e.g., sluicing vs. chemical dissolution versus dry mechanical retrieval methods)
- Accounting for the physical and chemical processes controlling radionuclide release from the source term resulting from the use of different technologies in retrieval steps
- Determining the retrieval endpoints on the basis of risk associated with the fate and transport of radionuclides through the vadose zone to the point of compliance.

CONCLUSIONS

- The ongoing chemical cleaning technology development tasks will provide a strategy for optimized retrieval of SRS waste tank heels involving minimal oxalate additions and the retrieval of alpha-emitting radionuclides.
- New chemical cleaning approaches for the retrieval of more diverse Hanford wastes will be needed.
- Ongoing characterization efforts may lead to more cost-effective and practical tank waste characterization.
- Quantitative, scientifically defensible models of contaminant release from tank residuals are needed to inform risk-based tank closure decisions.
- Quantifying the long-term risk reduction benefits as a function of the amount of remaining tank heel may provide an alternative to the tank-closure metrics based on volume or "limits of technology" currently being used.
- Chemical stabilization of residual tank waste combined with risk-informed closure could support retrieval endpoints other than those based on volume or the "limits of technology" and may result in a greater level of protection to human health and the environment.

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