

DOE STRATEGY FOR HLW RADIOACTIVE WASTE TANK CLOSURES

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ABSTRACT

The U.S. Department of Energy (DOE) manages high-level waste (HLW) at four sites located throughout the country. These wastes are primarily stored in large underground storage tanks, some of which have been in service since the late 1940's. The wastes in these tanks pose a potential hazard to the public health and safety. DOE is committed to eventual retrieval and treatment of these wastes for disposal, followed by disposition and closure of all the facilities involved in managing these HLW.

Because of the large number of tanks used to store HLW, and attendant resources associated with operating and monitoring the tanks, efforts have begun to retrieve the wastes in these tanks, and close the tanks. Various approaches are being evaluated, with two tanks already having been operationally closed at the Savannah River Site (SRS).

The purpose of this paper is to provide a summary of the DOE strategy and approach for closing HLW radioactive storage tanks.

BACKGROUND

Over the past 50 years, the U.S. Department of Energy and its predecessor agencies have operated an extensive nuclear materials production complex to produce materials for defense and research purposes. A large part of this complex entailed the reprocessing of spent nuclear fuel for the purpose of extracting valuable materials. One significant byproduct of this reprocessing was the generation of high-level radioactive waste (HLW). This waste was primarily produced at four DOE sites: 1) the Savannah River Site located in South Carolina, 2) the Hanford site in Washington state, 3) the Idaho National Engineering and Environmental Laboratory (INEEL) in Idaho, and 4) the West Valley Demonstration Project (WVDP) in western New York state.

HLW is stored at four of these sites in large underground storage tanks, ranging in size from small tanks on the order of 5,000 gallons, to much larger tanks with capacities of over a million gallons. Some of these tanks have been in service since the mid to late 1940's. Over 240 HLW storage tanks were constructed for this purpose. The bulk of such tanks are fabricated of mild carbon steel, with only INEEL possessing stainless steel tanks. The ultimate goal of the Department's HLW management program is to retrieve the HLW and other wastes from these tanks, treat the wastes to an acceptable form for disposal at a federal geologic repository, and disposition and close facilities used during management of HLW.

SUMMARY STATUS

Over the past three years the Department has intensified its efforts in planning and implementing closure of these HLW storage tanks. The differing regulatory and technical considerations (e.g., waste characteristics, number and configuration of tanks, availability of HLW treatment facilities, etc.) present at each site, do not allow a uniform approach. Consequently, each of the four sites managing HLW is in a different stage of progress in planning for and closing their HLW tanks.

At the Savannah River Site, two HLW tanks have been operationally closed. These tanks have been removed from service and stabilized with an immobilization material to ensure that residual radionuclides do not pose a hazard to the public health and safety, and the environment. At the INEEL, the disposition of their HLW tanks will be determined, in part, through completion of a comprehensive High Level Waste and Facilities Disposition Environmental Impact Statement, that will enable decision-makers to select strategies and approaches for closing their tanks.

The Hanford site, which has the largest number of HLW storage tanks, 177, has entered a consent order (Tri-Party Agreement) with the state of Washington and the Environmental Protection Agency (EPA) for removal of a fixed percentage of waste volume from the storage tanks. At the WVDP, a draft Environmental Impact Statement (EIS) for site closure, including final disposition of the storage tanks, has been prepared. Different waste retrieval technologies are being evaluated, consistent with alternatives in the EIS.

Although each HLW site possesses unique tank closure considerations, the Department has implemented several integration efforts to promote sharing of lessons-learned from tank retrieval and closure activities, and to provide a regulatory pathway for tank closure activities. One such activity is the sponsorship of two complex-wide radioactive waste tank closure workshops that were attended by DOE federal and contractor representatives, local regulators and stakeholders, and national regulator or oversight organizations. Another activity is the recent preparation of a DOE directive on radioactive waste management that recognizes the need to provide a regulatory basis for HLW tank closure activities that ensures protection of the public health and safety, and the environment.

STRATEGY

Because of the unique nature of the regulatory climate and technical considerations at the four HLW sites, the Office of Waste Management, working with these sites, has elected to provide an infrastructure that establishes overall policy for tank closure activities but does not dictate specific approaches for the sites to follow.

A High Level Waste Steering Committee (HLWSC) was established in 1996 to provide policies, planning, guidance, and the integration of an effective and efficient national HLW program. This committee is comprised of managers at field offices and Headquarters with HLW management responsibilities. The HLCWSC has sponsored and endorsed several integration efforts related to HLW tank closures:

- Sponsorship of two complex-wide radioactive waste tank closure workshops,
- Endorsement of the development of a HLW end-state plan that describes a strategic plan for achieving completion of the HLW program, including disposition of facilities such as storage tanks, and
- Promotes the sharing of information between the sites on a number of HLW management issues, e.g., a workshop conducted by SRS on lessons-learned from the operational closure of two of their tanks.

The Department uses a directives system to implement its regulatory authority for the management of nuclear facilities, including radioactive waste management facilities, at DOE sites. A key directive controlling the closure of HLW tanks is the directive for Radioactive Waste Management. A recent revision to that directive contains two provisions that bear upon tank closure planning: 1) a process for performing waste incidental to reprocessing determinations whose successful outcome would allow residual wastes in HLW tanks to be managed as a waste type other than HLW, and 2) a requirement for the preparation of a closure plan that addresses key aspects of HLW facility closure. That directive is scheduled for issue in March 1999.

Another area of complex-wide support is the development of new technologies and data to facilitate tank closure decisions and activities. The Office of Science Technology operates a Tanks Focus Area (TFA) to develop technical solutions to enable and enhance the cleanup of DOE's waste tanks and other associated facilities. One of the TFA's specific technical areas of investigation is closure. Through the closure work element, the TFA has provided specific support in development of technologies or data in the areas of:

- Tank heel retrieval and tank cleaning
- Waste inventory assessment
- Closed facility performance assessment
- Tank stabilization methods

SITE-SPECIFIC STATUS OF CLOSURE

Savannah River Site

The SRS has 51 HLW tanks divided between the F and H area tank farms and vary in capacity from 750,000 to 1,300,000 million gallons. These tanks were constructed over an approximate 35-year window, from the early 1950's through the mid-1980's. These tanks were constructed of mild steel and were designed to store the HLW produced by the operation of the PUREX extraction process to remove plutonium and uranium from reprocessed spent nuclear fuel. The acidic HLW produced as the result of operating the PUREX process was neutralized and transferred to the tanks for storage. Twenty-seven of the tanks are of a double confinement construction.

The HLW tanks are permitted under a waste water operating permit, and closure, for purposes of state regulations, will be through closure of the waste-water operating permit. The primary regulatory driver governing waste removal from the tanks at the site is the Federal Facilities Agreement between DOE-SRS, the state of South Carolina, and the Environmental Protection Agency. A stipulation of this agreement is that the state approve an overall tank waste removal plan and schedule.

SRS has prepared and submitted a Tank Closure Plan to the state of South Carolina (1). Significant features of the closure plan include:

- 1) Identification of performance objectives,
- 2) Discussion of closure approaches to meet the objectives,
- 3) Technical argument for obtaining a waste incidental to reprocessing determination, and
- 4) Provisions for performing closure that effectively removes the tank from any controls, yet is consistent with subsequent closure of a larger area under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

The plan was approved by the state and EPA in 1996, with the understanding that DOE would make a 'waste incidental to reprocessing' determination that the residues in the tank could be managed as a waste form other than HLW, but that DOE would seek validation from the Nuclear Regulatory Commission (NRC) that the methodology for making the determination was adequate. An Environmental Assessment addressing the full tank closure program was also performed in 1996, resulting in a Finding of No Significant Impact.

In 1997 SRS completed operational closure of two HLW storage tanks, Tanks 17 and 20. Bulk waste removal had already been performed on these tanks and they were known to have comparatively low levels of residual radioactive waste. A waste incidental to reprocessing determination was performed indicating that completion of tank closure activities would satisfy incidental waste criteria. A reducing grout was initially added to mix with and immobilize residual waste into a matrix. That layer was followed by the pouring of a fairly large layer of a controlled low-strength grout material, with the tank capped by addition of a high-strength grout.

No further tank closures are planned through the year 2001. In 1999 SRS will initiate an Environmental Impact Statement to address the environmental impacts of closing the remaining HLW tanks on the site.

INEEL

The HLW at the INEEL is located on an area of the site called the Idaho Nuclear Engineering Technology Center (INTEC). The INTEC's original function was to reprocess government-owned nuclear fuels from research and defense reactors, much of it generated by the Navy's Nuclear Power Program. The facility recovered rare gases and uranium for reuse from the spent nuclear fuel. The reprocessed HLW at INEEL was also an acidic product; however it was not

neutralized and hence stainless steel tanks were used for storage. Eleven primary tanks of 300,000 gallon capacity were constructed, all of which include a secondary unlined, concrete vault, but which would not satisfy Resource Conservation and Recovery Act (RCRA) requirements for double containment. Four smaller 30,000 gallon tanks are also part of the INTEC tank system.

Commencing in 1963 much of the liquid acidic waste has been retrieved from the storage tanks and converted to a solid, dry powder through the use of a calcine process. The calcine material is then delivered via a pneumatic system to separate stainless steel, shielded bins for long-term storage. As of 1998, all the readily retrievable HLW had been calcined and transferred to the calcine bins. Only HLW residues and sodium-bearing wastes that resulted from decontamination activities and cleanup of solvent used to recover uranium, remains in a liquid form in the storage tanks.

Several closure options have been evaluated for the INEEL tank farm. The options include several different approaches for tank stabilization materials, depending upon whether the materials meet CERCLA, RCRA, or non-hazardous low-level waste requirements. Physical closure options range from the complete removal of tank facilities and cleanup of associated soils, to bulk waste removal and stabilizing residues with the low-activity waste fraction of separated HLW.

The INTEC facility is currently considered a separate Waste Area Group under CERCLA. Closure of the HLW tanks must be integrated into the final disposition of the entire INTEC facility. Because the INEEL HLW contains hazardous constituents closure of the INTEC tanks must meet RCRA requirements. Coordination between RCRA and CERCLA requirements will be necessary as closure activities commence. DOE-ID is currently preparing a draft Idaho HLW and Facilities Disposition EIS that will facilitate identification of regulatory issues for INEEL tank closures.

Another regulatory driver for tank closure is the Settlement Agreement to a Notice of Non-compliance Consent Order. This Settlement Agreement, between DOE and the State of Idaho, requires all liquid wastes in the INTEC tanks to be calcined by 2012, and ceasing use of certain tanks for liquid waste storage by 2003.

Hanford

Hanford has the largest number of HLW storage tanks, 177. Because a number of different spent nuclear fuel reprocessing approaches were applied at the Hanford site, the waste tends to be more heterogeneous than at the other sites, which also contributed to the need for more tanks. As at the Savannah River Site, all the HLW has been neutralized and is stored in mild-steel tanks. These tanks include 149 single-shell tanks constructed from 1943 through 1964, and 28 double-shell tanks constructed from 1986 through 1986.

The primary comprehensive regulatory driver for HLW tank closure activities at Hanford is the Tri-Party Agreement (TPA), and 2) the Tank Waste Remediation System (TWRS) EIS and associated Record of Decision. The TPA is a consent order between DOE, EPA and the state of Washington, and establishes milestones for waste retrieval and HLW tank closure. It specifically requires:

- HLW to be retrieved from the 149 single-shell tanks by 2018,
- Submittal of a plan to the state for closure of the first tank by 2004, and
- All single-shell tanks to be closed by 2024.

The TPA also includes targets for the amount of waste to be removed from the HLW storage tanks. In part, because of past leakages of HLW from single-shell tanks, the TPA stipulates that liquids in the single-shell tanks shall be transferred to the double-shell tanks by 2001.

The overall Hanford site tank waste remediation strategy is described in the Record of Decision for the TWRS EIS. It identifies the decisions for retrieving the waste from the tanks and immobilizing it for subsequent disposal. The EIS and ROD acknowledge that closure decisions for HLW tanks will be reached through a subsequent EIS or other National Environmental Policy Act process.

Major efforts that have been performed or are ongoing in support of tank closure include: 1) demonstrations of waste retrieval technologies, 2) characterization of contaminants in soils from HLW tank leaks, and 3) evaluation of impacts resulting from closure of a representative tank farm. A number of specific activities within these efforts will be performed within the Hanford Tanks Initiative (HTI). HTI was initiated in 1996 to develop, demonstrate, and deploy technologies to support the HLW tank retrieval mission. In January of this year the primary functions of the TWRS transitioned to the Office of River Protection. Additionally, HTI will be used to develop criteria and methodology for waste retrieval performance in the form of a report called the Retrieval Performance Evaluation (RPE).

The primary regulatory driver for closure of HLW tanks at Hanford is RCRA. As at the SRS and INEEL, it is anticipated that a waste incidental to reprocessing determination will be made, in conjunction with the NRC, for the residues remaining in the closed tanks.

West Valley Demonstration Project

Unlike the other HLW sites, activities conducted at the WVDP are under the broad requirements of a law, the West Valley Demonstration Project Act. The purpose of the act was to demonstrate the solidification and preparation of HLW for permanent disposal, but also included provisions for the federal government to decommission the HLW tanks and project facilities. The Act also directed the NRC to have an oversight role and to prescribe decontamination and decommissioning criteria for the HLW tanks and WVDP facilities. NRC staff have proposed some decommissioning criteria for WVDP to the Commissioners. These criteria are documented

in an NRC Policy Issue paper and are expected to be formally prescribed after completion of the EIS process for closure of the entire site (1).

The WVDP is the site of the only commercial spent nuclear fuel reprocessing facility operated in the United States. Under a license by the NRC, Nuclear Fuel Services reprocessed approximately 640 metric tons of spent fuel during the period 1966 to 1972. Most of the resulting HLW, approximately 670,000 gallons was neutralized and stored in two large carbon steel, single-shell HLW storage tanks. Another smaller volume of acidic Thorex waste was stored in one of two smaller stainless steel tanks. That waste has subsequently been blended with the neutralized waste for treatment. As of early 1999, about 90 percent of the waste had been retrieved and immobilized, through vitrification, in a borosilicate glass waste form.

Current HLW tank closure efforts are guided by the draft EIS for closure of the site as a whole. HLW tank closure alternatives evaluated in that EIS vary from complete removal and cleanup that would allow unrestricted use, to an in-place stabilization of the residues in the tanks. The final EIS will further refine these approaches, invoke a set of decommissioning criteria, and incorporate the recommendations of the WVDP Citizens Task Force. This group prepared a report (2) containing several recommendations, the more significant to tank closure being:

- The site is not suitable for long-term, permanent storage, or disposal of long-lived radionuclides;
- Groundwater should be protected; and
- A reliable method is needed to assure funding will be available to implement the preferred alternative.

Physical efforts are currently concentrated on evaluating the effectiveness of various residual waste retrieval techniques. A mock-up facility has been constructed on the site that permits evaluation of various technologies for waste retrieval. Additionally, water additions to the tank to permit further bulk waste removal is ongoing.

SUMMARY

The status of closure activities at each of the four HLW sites varies according to waste retrieval activities, availability of HLW treatment processes, and the local regulatory climate. The attached figure summarizes the essential aspects of the closure process at each of the sites.

REFERENCES

1. DOE, *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste Tank Systems, Savannah River Site, Construction Permit Numbers 14,338, 14,520, 17,424-IW*, Revision 1, Savannah River Operations Office, Aiken, South Carolina, (1996)
2. U.S. NRC, SECY-98-251. *Decommissioning Criteria for West Valley*, (1998)
3. West Valley Citizen Task Force, *West Valley Citizen Task Force Final Report*, (1998)

Figure 1. Status of High-Level Waste Tank Closure Activities

	INEEL	Hanford	WVDP	Savannah River
Status of Tank Closure	· By 2012 cease use of HLW tanks · Closure to begin in 2003 with a demonstration	· SST pumpable liquids transferred to DST · Closure plans required in 2004 · Single-shell tanks to be closed by 2024	· Residual waste removal to begin in 1999	· Two tanks operationally closed · 2 more tanks expected to be operationally closed by FY2002 □ Single-shell tanks to be closed by 2022
Potential Physical End State of Tanks	· Small tank heel to remain · Stabilization materials (grout) to be added to heel	· Future NEPA process will clarify performance specifications and tank configuration	· Small tank heel to remain · Grout and zeolite added to heel	· Dependent on performance objectives · Reducing grout added to heel. Low-strength grout added to heel
Regulatory Authority for Closure	· RCRA and CERCLA integration · NRC Agreement on incidental waste	· RCRA (CERCLA to identify ARARs) · NRC agreement on incidental waste	· RCRA · NRC agreement on incidental waste	· Wastewater operating permit · CERCLA-like approach · NRC agreement on incidental waste
Status of Site End State Closure Decisions	· Settlement Agreement sets timelines for waste removal · CERCLA RODs will decide soil cleanup	· Subsequent NEPA will be done on closure □ Hanford Tank Initiative to assist in closure criteria identification	· EIS will identify end state of tanks	· CERCLA closure of entire tank farm pending