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Review of Tank Lay-Up Status at U.S. Department of Energy Radioactive Waste Tank Sites

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C. Henderson*

March 5, 2002

* Jacobs Engineering Group, Inc.

Prepared for the U.S. Department of Energy
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Jacobs Engineering Group, Inc., and
Pacific Northwest National Laboratory
Richland, Washington 99352

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APPENDICES

LIST OF TERMS

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DOE	U.S. Department of Energy
FY	fiscal year
HLW	high-level waste
HSEE	heel sampling end effector
SST	single-shell tank
INEEL	Idaho National Engineering and Environmental Laboratory
LDUA	light-duty utility arm
ORR	Oak Ridge Reservation
RCRA	*Resource Conservation and Recovery Act of 1976*
ROD	Record of Decision
SRS	Savannah River Site
WIR	waste incidental to reprocessing

1.0 PURPOSE AND BACKGROUND

During fiscal year (FY) 2001 as part of a Tanks Focus Area strategic initiative, tank lay-up options were developed and evaluated for the two high-level waste (HLW) storage tanks at the West Valley Demonstration Project (Henderson 2001a, b, c, d, e). As a follow-on task, a list of key contacts throughout the U.S. Department of Energy (DOE) complex was developed (included as Appendix A). Visits were then made to discuss the concept and applicability of tank lay-up. This report documents the results of individual discussions with tank closure staff at the four DOE Sites concerning tank closure status and plans as well as lay-up options and activities.

To provide some focus and structure to the Site discussions, a tank lay-up information package and questionnaire was developed and provided before each Site visit (Appendix B). Tank lay-up discussions were held with management and technical staff from Hanford Site and Idaho National Engineering and Environmental Laboratory (INEEL) in December 2001 and with Hanford Site and Savannah River Site (SRS) and Oak Ridge Reservation (ORR) management and technical staff in January 2002. Discussion topics included current closure schedules, plans, progress, and issues that need to be addressed before closure.

Tank lay-up follows the completion of a tank storage mission and is a temporary, transitional state of the tank on the path to final closure. Tank lay-up can be defined as placing a tank and its residual contents into a safe, stable, and minimum-maintenance condition pending, and without precluding, final closure options. The need for and potential benefits from tank lay-up depend on the following:

- Number and physical condition of tanks
- Expected lay-up period
- Uncertainty in closure requirements
- Perceived risks associated with waste heels
- Regulatory environment.

Tank lay-up may occur in phases as (1) funding is available; (2) final closure requirements become known; and (3) identified issues are resolved by new technologies, better information, and/or stakeholder acceptance.

Tank closure program decisions are driven by many Site-specific and tank-specific variables. The better the Site has knowledge and control of these variables, the faster and easier the closure plans will be developed and approved. Tank lay-up options will vary among Sites and perhaps even between tanks at the same Site. Site-specific variables include the following:

- **Site Physical Conditions –** Soil chemistry, geology, hydrology, seismology, meteorology; vulnerability to hostile actions; proximity to cities and to publicly accessible water sources

- **Tank and Tank Farm Conditions –** Tank ages, designs (single- or double-lined, size, materials of construction, in-tank equipment); composition and extent of surface and subsurface contamination from tank and other sources; classification, composition, configuration, and perceived risk of residual tank waste

- **Federal Facility Agreements and Regulatory Requirements –** *Resource Conservation and Recovery Act of 1976* (RCRA) versus *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA)

- **Relationship with and Involvement of Stakeholders –** Tribes, locals, downwinders, advisory boards

- **Closure Schedules –** Cost versus available funding profiles

- **State of Closure Technologies –** Availability, adaptability, performance, cost-benefit, maturity, acceptability, applicability

- **Complexity and Resolution of Issues –** Future land use designation; results (and acceptance of results) of contaminant release/transport modeling; post-closure requirements; disposal options, including allowances for heel dilution with fill materials.

As part of the closure planning process, baseline documentation will be reviewed for requirements that can be renegotiated, modified, waived, relaxed, or eliminated along the final closure path. Documentation that could be impacted by lay-up planning includes operating specifications, technical safety requirements, safety analysis reports, and procedures.

Tank lay-up activities (e.g., reducing tank chemical and radiochemical inventories, stabilizing residual waste heels, isolating tanks, stabilizing tanks) are expected to reduce the perceived risks associated with the tanks. Likewise, subsequent hazard/accident analyses on a tank-by-tank basis could result in the following:

- Lowering the hazard classification for certain facilities, which could impact conduct of operations, hazardous waste management, emergency preparedness, and training

- Reduction in the number of safety-class, safety-significant, and defense-in-depth structures, systems, and components, which could reduce the number of required engineered and administrative controls

- Reduction in the number of technical safety requirements (e.g., safety limits, limiting control settings, limiting conditions for operation)

- Reduction in monitoring or surveillance frequencies (e.g., liquid/solids levels, waste temperatures, vapor space pressures, leak detection probing, corrosion prevention)

- Reduction in tank reporting requirements

- Reduction of maintenance on the tanks and supporting and interfacing systems (e.g., vapor space filtration, liquid level devices, temperature probes, light-duty utility arm [LDUA], core sampling system)

- Reduction in the interface requirements associated with non-tank facilities and systems

- Reduction in configuration management requirements, procedure maintenance, number and depth of assessments, required personnel training, hazardous materials and radiation protection requirements, and other requirements to be determined on a Site and tank basis.

The baseline closure strategy for three of the Sites (ORR, INEEL, SRS) is to clean out the tanks to meet closure criteria, then fill the tanks and ancillary equipment with grout. The Hanford Site is currently developing its baseline closure strategy as part of a planned tank closure demonstration. At all Sites, final closure of the tanks would occur as part of final closure of the associated tank farms or sites. Closure of the highest-risk tanks at all four Sites is planned for completion during the next 20 years; closure of the remaining tanks will occur as storage missions are complete.

2.0 SITE PROGRESS TOWARD TANK LAY-UP

Each Site has shown progress on the path to final closure of tanks. The following sections summarize progress for each Site.

2.1 OAK RIDGE RESERVATION

All but 3 of 40 inactive tanks have been closed under the ORR Federal Facility Agreement (DOE/OR-1014), 25 tanks in FY 2001 alone. Because closures were governed by a CERCLA process, work proceeded under remediation plans rather than closure plans for the tanks. Waste characterization plans were developed that preceded and supported the remediation plans. Several remedial action reports have been issued (DOE/OR/01-1955&D1; DOE/OR/01-1953&D2; DOE/OR/01-1953&D2/A2). Because work is proceeding under an interim Record of Decision (ROD), these remedial action reports actually define interim disposal actions that could become final once the ROD becomes final.

Regulator agreement early in the process was crucial. The regulators agreed to a closure program based on accepted (10^{-6} incidental lifetime cancer risk) criteria and modeling. The disposal unit source term model was used, and the regulators agreed to accept the results from the modeling. Additionally, the regulators were involved in the sampling and characterization of the residual waste heels. Following a demonstration of multiple-point sampling and analysis from one tank, agreement was reached that the remaining tanks could be characterized using single-point samples.

The Providence Group was the key ORR closure subcontractor. Using a variety of existing technologies, the bulk sludge (as well as 95% of the radioactivity) was removed from the tanks to the extent practical, and consolidated in the Melton Valley Storage Tanks. Some of the key technologies integrated into the closure program included the following:

- The Houdini, with rotating end effector
- Pulse air and Flygt mixers
- Russian pulsating mixer pumps
- High-pressure, multiple-site grout injection system
- Installation of new access risers in the tank domes.

The tanks and associated piping were then filled with a flowable, self-leveling grout. Subcontractors developed the grout recipes, eventually settling on one called "Harrison mix 80" (SPG-OR051-A001; SPG-OR003-A001). While no attempt was made to intimately mix grout with residual heels, credit was allowed for full grout dilution of the transuranic residual waste heels. Foster-Wheeler is building a treatment plant for the sludges, allowing for eventual disposal at the Waste Isolation Pilot Plant. Some of the tanks were closed without further sludge retrieval.

It was determined that the Authorization Basis for the inactive ORR tanks was not consistent throughout the farms, and revamped the system to ensure all tanks were handled the same. A 15-minute video depicting the successes of the closure program, including in-tank views of some of the robotics used to retrieve the wastes was also developed.

Closure of the remaining three inactive tanks, which contain resin beads (and are in groundwater), was covered by a ROD that has been withdrawn because of the funding uncertainties associated with the current DOE-Environmental Management scope and budget review. If these resin tanks are not funded for closure, they will probably not be lay-up candidates because they are already in a low-risk, low-maintenance condition.

By strict definition closure of the ORR tanks is not final because the tank areas themselves have not yet been closed; this may occur much later under a separate ROD. The tanks are within the Oak Ridge National Laboratory, which is approved in perpetuity for government/industrial use.

The ORR staff are eager to share lessons learned, both successes and failures, and would support continued dialogue among the Sites on tank lay-up. Closure of the Melton Valley Storage Tanks may benefit from this continued dialogue.

2.2 IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

INEEL is pursuing an aggressive program to complete RCRA closure of all 11 stainless steel HLW storage tanks by FY 2016. Clean closure of these tanks requires an extensive retrieval and decontamination program. A RCRA closure plan was submitted to the state of Idaho in December 2000 and comments were received in March 2001. A revised closure plan was submitted in May 2001 and the state still objected to the approach for evaluating groundwater risk. A new plan was submitted to the state in November 2001; state response to this latest plan is expected in February 2002.

A Tier 1 closure plan was also prepared in accordance with the requirements of *Radioactive Waste Management* (DOE O 435.1) for approval by DOE. This plan was submitted for DOE-Headquarters review in January 2002; approval is anticipated in March 2002.

The liquid tank waste is stored in acid form with very few solids. None of the tanks have failed, and leakage during waste retrieval and tank decontamination operations is not a big concern. INEEL expects to fill the first two tanks with grout by the end of FY 2004, and an accelerated plan to increase that number to five tanks is being considered. Closure plans are being finalized to meet the RCRA requirement to have an approved closure plan within 90 days of 'ceasing use,' and to fill tanks with grout within one year after cleaning. There would still be CERLA actions required to close the entire tank farm.

Calcination of all high-level liquid waste at INEEL was completed in 1998. The liquid waste remaining in the INEEL tanks is process equipment waste from evaporator operation and sodium-bearing decontamination solutions. This remaining liquid waste is known as sodium-bearing waste. Current plans are to treat this waste by a method other than calcination. The plan is to reclassify this waste as waste incidental to reprocessing (WIR) according to DOE O 435.1 to expand the treatment and disposal options.

The tank clean up and closure activities are considered as ‘off-normal operations, so unreviewed safety question evaluations are required. Also, an addendum to the safety analysis report is being prepared to modify the Authorization Basis.

INEEL intends to reuse several components for tank cleaning and grouting, such as the wash ball and directional nozzle cleaning system and the grout delivery system. ‘Interface adapters’ to isolate the tanks before grouting have also been developed. These are inserts to put in transfer piping with a blind flange and connections on either side of the flange to remove or add materials to the tank being closed while isolating it from the rest of the tank farm system. Ancillary equipment and systems will be grouted in a similar manner.

INEEL is also developing a new method for sampling the solids in the residual waste heels in the tanks. This sampler is deployed using the LDUA. The heel sampling end effector (HSEE) provides the ability to access off-riser locations over a large area of the tank bottom to obtain representative heel samples up to 800 mL (0.2 gal) in volume. The HSEE contains a light source, a camera with a viewing range of 0 to 15 m (0 to 50 ft), and a radiation detector with a range of 0-1000 rad/h. The HSEE is constructed of stainless steel, weighs about 30.5 kg (67 lbs), and has a remotely detachable sample chamber.

The wash ball is the primary remediation technology selected for tank cleaning. The wash ball nozzles operate at relatively low pressure (0.69 MPa [100 psi]) and a relatively high flow rate [0.0047 m^3/sec (75 gal/min)]. In the tank, the nozzle maximum stand-off distance is approximately10.7 m (35 ft). The wash ball is supplemented by a directional nozzle system. Similar to the ‘sluicing nozzle’ used at Hanford, the manually-controlled directional nozzle will be used to direct streams of water to the tank walls, cooling coils, or floor to dislodge accumulations of tenacious solids, and to sweep solids to the steam jet intake.

INEEL has demonstrated a method of pouring grout onto a tank floor in such a manner to permit retrieval of additional slurry from the tank using a variable depth steam jet. Sequential pouring of the grout pushes liquid toward the jet intake, allowing removal of additional liquid from the large-diameter tanks.

INEEL has demonstrated successful deployment of the LDUA for sampling and inspection. The LDUA could be a very effective tool to assist with cleaning of the tanks if a portion of the walls, floor, or other internal structures turn out to be more difficult to clean. Another option is a simpler articulated mast like the maintenance arm used at Hanford or the Wiedeman arm used at the West Valley Demonstration Project. These devices can easily fit through the 31 cm (12 in.) diameter risers at INEEL and can be used to deploy a high-pressure lance for more aggressive cleaning.

INEEL would be very important participants in future dialogue on tank lay-up.

2.3 SAVANNAH RIVER SITE

Closure of the 24 SRS HLW storage tanks that do not meet secondary containment requirements is planned to be completed by FY 2022. The remaining 27 tanks will be closed when the storage mission is complete in FY 2028. The associated tank farms will be closed at a later time.

The SRS tank closure evaluation was worked on for six years, and issued a Tier I closure plan to DOE-Headquarters for approval, which is expected during the second quarter of FY 2002. An independent review of the closure plan has been completed and comments are being resolved. In establishing the performance objectives for HLW tank system closure, DOE has assumed that the residual waste material remaining in the tank at closure will not be managed as HLW. In accordance with DOE O 435.1, DOE will demonstrate that the residual waste is WIR. SRS also estimated the HLW holdup in the piping and ancillary systems as 20% of the total inventory.

SRS regulatory points of compliance are seeplines about 0.6 km (1 mi) from the tank farm areas. Development of a three-dimensional model of the groundwater-vadose zone is being considered because it could provide more flexibility in planning than does the current one-dimensional model. Good regulatory support has been received from NUS Corporation, Sandia National Laboratories, and the Savannah River Technical Center.

The SRS tank closure environmental impact statement proposes the tank farm areas be considered for industrial land use in the future. This means the Site would remain under the ownership of the federal government (National Environmental Research Park), prohibiting residential uses and limiting recreational opportunities.

Tanks 17 and 20 have already been closed under CERCLA and the South Carolina Department of Health and Environmental Control industrial wastewater permits regulating their operation. Legal issues raised subsequent to the closure of these two tanks are being resolved. Bulk waste was removed from each tank down to less than 113,550 L (30,000 gal), then four 200 horsepower, 2,000-hour life mixer pumps were installed at a cost of $4 million per pump. Oxalic acid was used to help clean out the tanks, and each was left with the equivalent of 3,785 L (1,000 gal) of the original heel, the maximum allowable under their performance assessment. Finally, the tanks were filled with three distinct types of grout: a reducing grout to stabilize the heel, a low-strength grout to fill the majority of the tank, and a high-strength grout cap to inhibit human intrusion. Two buried solvent extraction storage tanks have also been CERCLA closed at the Site.

Tanks 18 and 19 are scheduled for closure by FY 2004; preparation of Tier II closure plans is already underway. Closure planning will include a WIR determination for each tank. The SRS will not be able to transfer some of the tank closure technologies used by other Sites (e.g., the Houdini system and the LDUA) because of the cost of maintaining these systems for their larger and differently configured tanks or because they require too much supporting superstructure over the tanks. The following technologies have been deployed in Tanks 18 and 19: Flygt mixers, Bibo transfer pump, Pitbull pump, Khrone density meter, hydrolance, and Goulds transfer pump.

During FY 2002 they expect to install a newly developed corrosion probe in Tank 43, procure and test an annulus inspection crawler, conduct laboratory scale demonstrations of leak mitigation technologies, complete hot testing of Khlopin acid for tank sludge removal, and evaluate an industrial pipeline unplugging system.

A phased lay-up is being considered for Tank 11, reviewing and changing the tank Authorization Basis to allow the tank to be maintained in a safer condition and cheaper. This includes placing a rain barrier/collection system over the tank. Like other Sites, caustic, nitrites, and nitrates to residual heels are added to inhibit tank corrosion.

A video considered important to public relations was produced to help develop understanding and support for the Site closure program. The video contained interviews with many prominent politicians and leaders and was widely available for local, state, and DOE-Headquarters meetings.

SRS representatives were receptive to the idea of a web-based tank lay-up/closure reference library but undecided about the value of a workshop.

2.4 HANFORD SITE

The Hanford Site contains 177 HLW underground storage tanks located in 18 tank farms on two separate areas. There are 149 of the older (up to 60 years old) single-shell tanks (SSTs), each consisting of a reinforced-concrete vault with a single carbon steel liner, that are currently planned to be emptied by FY 2027 and then closed. Sixty-seven of these tanks are known or assumed to have leaked to the soil. The 28 newer tanks each have two carbon steel liners, none are known to have leaked, and all are to be emptied and closed by FY 2032. A Tier 1 general tank closure plan is scheduled for issuance in FY 2008. Planning is currently underway on an accelerated tank closure demonstration project that would operationally close four or five of the SSTs by FY 2004.

The primary focus of the tank remediation program over the past decade has been on waste characterization and retrieval due to the need to remove the waste from the failing SST as soon as possible and to provide feed to a planned vitrification facility. Liquid-based waste retrieval systems currently under consideration include salt cake dissolution for tanks containing salt cake, a crawler system for tanks containing sludge, and fluidic mixing systems for tanks that contain both salt cake and sludge. This has also led to development and field testing of leak detection systems (e.g., electrical resistance tomography, high-resolution resistivity, and cross borehole radar) and leak mitigation strategies, as well as extensive three-dimensional modeling of the transport of tank waste through the Hanford vadose zone and groundwater.

Closure of the Hanford tanks will occur under DOE O 435.1 and the Washington State "Hazardous Waste Management Act" and its implementing "Dangerous Waste Regulations" (WAC-173-303). The current closure strategy assumes waste retrieval will be sufficient that the residual heel can be determined WIR. This strategy also assumes the residual heels and other tank farm sources will be considered non-HLW by the U.S. Nuclear Regulatory Commission.

Closure of the Hanford tanks and the surrounding soil is greatly complicated by the large number of failed tanks as well as an estimated 3.8 million L (1 million gal) of tank wastes that are now in the surrounding vadose zone and groundwater. Eight of the 12 SST farms have been placed into the RCRA Corrective Action Program, and evaluation of the closure options for some of these tanks has concluded that clean closure would result in a substantial commitment of resources for minor reductions in long-term impacts. The planned land use for the areas containing the closed tank farms is industrial-exclusive for at least 50 years. During the 1980s extensive design, fabrication, and demonstration of a full-scale, no-maintenance, 10,000-year final barrier for placement over the tank farms was conducted. Likewise, a prototype 'rock slinger' was procured and tested to allow basalt rocks to be placed into tanks as fill material; and field-testing of subsurface barriers (e.g., grout) was conducted. More recently, Hanford has been investigating an 'Apatite-based' compound for potential use as a subsurface chemical barrier.

Hanford may derive the most benefit from continuing intersite dialogue on tank lay-up, especially during the early phases of detailed planning for tank operational closure.

3.0 CONCLUSIONS AND RECOMMENDATIONS

The following are conclusions and recommendations derived from the information received and developed during this task.

- There is a wealth of knowledge, experience, and lessons-learned on tank lay-up and closure. Each Site will be reviewing and revising their Authorization Bases as part of closure planning. Hanford has the most to gain from what has been tried at other Sites. A lessons-learned workshop or videoconference, initially focusing on the changes in Authorization Bases associated with tank lay-up activities, should be considered.

- Various stakeholders have expressed an interest in developing meaningful information on the cost per 'closure unit' (e.g., curie, gallon) of tank closure activities at the Sites. Such cost data would be highly sensitive to each Site's initial conditions and the programmatic, technical, and regulatory frameworks for tank closure. Consideration should be given to adding this as a topic of discussion for a lessons-learned workshop or videoconference.

- The Site tank closure programs are at varying levels of maturity and may derive some benefit from continued dialogue on the tank lay-up concept. As currently planned, the Hanford tank closure demonstration should provide detailed lay-up requirements and costs, in a complex regulatory environment, for both small and large DOE HLW tanks. Consideration should be given to how Tanks Focus Area could provide meaningful support to the Hanford demonstration that would also benefit the other Sites.

- All Sites would contribute to and benefit from a tank lay-up/closure reference library. In the near term, assembling references may be complicated by comprehensive security review of documents at some of the Sites. Developing a user-friendly, comprehensive, readily accessible (perhaps web-based) reference library on tank lay-up/closure should be pursued.

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APPENDIX A

CONTACTS LIST FOR TANK LAY-UP

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APPENDIX B

SITE TANK LAY-UP QUESTIONNAIRE

The contents of this appendix have been previously distributed as JEG-01-031, *Tank Lay-Up Information Package and List of Questions for U.S. Department of Energy Waste Sites*.

B1.0 INTRODUCTION

This document provides background information and a list of questions to be addressed during an information-gathering visit by Jacobs Engineering Group Inc. (Jacobs) personnel. Jacobs has been funded by the Tanks Focus Area to complete a task "Pre-closure Interim Tank Maintenance." The overall objective of this task is to develop a central information center of site conditions, site requirements, alternative technical and other approaches, closure plans and activities, regulatory drivers and methodologies for decision-making to assist site decision-makers in the evaluation of alternative waste tank lay-up configurations. Lay-up is the term used for the period between initial decontamination and decommissioning of the tanks and final closure. Successful lay-up will place the tanks in a safe, stable, and minimum-maintenance mode until final closure.

B2.0 BACKGROUND

Subsequent to the end of tank retrieval activities but prior to final closure, U.S. Department of Energy (DOE) waste tank storage sites face challenges to appropriately maintaining aging tanks that still contain residual waste. These tanks must be kept in a stable configuration pending development and implementation of the final closure methods during a period that may exceed 10 years. Both in- and ex-tank concerns will impact the approaches selected. The alternative approaches available for achieving a stable interim configuration have not been evaluated for all tanks at all sites. Criteria for selection of preferred alternatives may vary from site to site. Special equipment to monitor and maintain the tanks may also need to be developed. Interim measures may include reducing corrosion, monitoring integrity, and maintaining structural stability. Lay-up strategies should be measured against criteria such as reducing monitoring and maintenance costs, meeting environmental regulations for tank closure, protecting worker and public health and safety, and addressing stakeholder concerns.

Current tank integrity efforts appear to be focusing on the (short-term) period when tanks are still active (for example, at the Hanford Site the emphasis is primarily on double-shell tanks and resolution of known safety issues). A Tank Integrity Workshop in November 2000 focused on the "period of time these tanks are required in completing the weapons complex cleanup." It is not clear that this period of concern includes the post-retrieval timeframe when the tanks may be considered inactive. Many of the tools and technologies being developed and used during a tank's active phase may also be applicable during its inactive phase (e.g., those for structural integrity and corrosion), but additional technologies may also be required to safely and responsibly manage the tank until it is closed, such as the following:

- More refined in-tank or ex-tank leak detection instrumentation and residual waste and vapor space characterization techniques (that possibly do not require physical sampling)
- Remote or automated monitoring of in-tank conditions
- Detailed, comprehensive, permanent visual records (and analysis) of the tank interior at specified frequencies
- Temporary interim barriers over or around the tanks until final barriers are in place.

During fiscal year 2001 Jacobs examined how a decision methodology developed for the West Valley Demonstration Project is applicable to the other DOE waste tank sites and determined what additional requirements and approaches will need to be considered. Additionally, a crosswalk of the lay- up requirements developed for West Valley was prepared against those identified for other sites. Table B1 is a comparison of the DOE tank sites. Table B2 summarizes the initial evaluation of tank lay-up requirements and considerations for each site.

B3.0 FISCAL YEAR 2002 PLANS

The task will continue in fiscal year 2002 with identification of characteristics unique to the individual sites and tanks (e.g., topography, meteorology, tank history, regulatory commitments, stakeholder concerns). Technical concerns to be considered during the evaluation include, but are not limited to the following:

- Prevention of internal tank corrosion (e.g., inhibitors, nitrogen inerting)
- Prevention of external tank corrosion (e.g., dehumidification, cathodic protection, inhibitors)
- Capability to monitor tank containment integrity (e.g., electrochemical noise, Raman spectroscopy, Corrosometer™, radiation detectors)
- Maintenance of structural integrity (maintenance or fill material)
- Development of treatment methods of air-borne contamination (filter disposal)
- Development of surface-fixation methods and material (coatings)
- Development of heel stabilization materials.

Jacobs will finalize a list of considerations or attributes applicable to the safe lay-up of waste tanks. The list of attributes shall address, at a minimum, regulatory, operational, technical, design, cost, and stakeholder concerns; safety concerns; and site-specific concerns and shall be organized or binned in a logical order. Each consideration shall be developed in sufficient detail to permit evaluation of intent and applicability to lay-up alternatives. The sites will provide comments and the list shall be finalized. Information needs will include the following:

- Tank type
- Tank condition
- Process history
- Heel condition
- Location
- Meteorological conditions
- Services
- Monitored variables
- Hazards
- Estimated duration of lay-up.

Table B1. Comparison of Site Waste Tank Programs (2 Sheets)

	WVDP	Hanford Site	SRS	INEEL	ORR
Number of tanks/areas to close	4/1 area	177/18 tank farms	51/2 tank farms	11[a]/1 tank farm	40/5 tank farms
Tank types	2	2	4	2 tank sizes	6
Tank sizes, 10^3 gal	15-750	55-1,160	750-1,300	300-318, 30	1.5-170
Tank ages, years	35	15-58	20-50	37-50	3-58
Tank conditions	No leakers	67 confirmed and assumed leakers	11 leakers	No leakers	No leakers
Waste types	Alkaline	Viscous, alkaline liquid, sludge, salt cake	Viscous, alkaline liquid, sludge, salt cake	Acidic, liquid sodium waste, sludges	Liquids, sludges
Waste volumes, 10^6 gal	0.6	54	33	1.4	0.4
Waste radionuclides, 10^6 Ci	0.03	200	470	0.52	0.047
Retrieval schedule	Tank heels cleaned out in 2001 to Class C limits	SSTs complete by 2018[b] and DSTs by 2028[b]	2019 for Type I, II, and IV; 2024 for Type III	HLW complete 1998; remaining liquid waste by 2012	90% of inactive tanks complete. Remainder as mission is completed
Closure schedule	Not yet finalized; closure expected to take up to 20 years	SSTs by 2024[b] and DSTs by 2032[b]	2022 for Type I, II, and IV; Type III by 2030	In six phases from 2002 to 2016	24 tanks without secondary containment by 2022; others as storage mission is completed
Tank maximum ages in years at closure	More than 50	More than 75	More than 75	More than 60	More than 70
Final closure requirements approved	No	No	Some top-level developed	Some top-level developed	No

Table B1. Comparison of Site Waste Tank Programs (2 Sheets)

	WVDP	Hanford Site	SRS	INEEL	ORR
Closure regulatory drivers	DOE/EIS-0226-D; NYSERDA 1980; WVDP Acts of 1980 & 1991	DOE/EIS-0189; DOE/EIS-0222F; Ecology et al. 1989; MOU 1996	DOE/EIS-0217; DOE/EIS-0303D; Site Treatment Plan; Supplemental EIS; Wastewater Closure Plan; WSRC-OS-94-42	DOE/EIS-0287D; DOE-ID 1992; Settlement Agreement; CERCLA; DOE O 435.1	Accelerated Cleanup Plan; DOE/OR-1014; CERCLA
Site and tank specific considerations and uncertainties	Corrosion, in-tank hardware; water in vaults	In-tank hardware; arid climate; well above water table; contaminated vadose zone/groundwater	In-tank hardware; some tanks in water table; 2 tanks interim closed in 1997	Tanks are stainless steel; in-tank hardware; seismic	Waste not classified as high-level; in-tank chunks of gunite

[a] Plus four 30,000 gal stainless tanks in the tank farm facility.
[b] Currently reevaluating to extend dates.

DST = double-shell tank.
EIS = environmental impact statement.
FFCA = Federal Facility Compliance Agreement.
HLW = high-level waste.
INEEL = Idaho National Engineering and Environmental Laboratory.
MOU = memorandum of understanding.
ORR = Oak Ridge Reservation.
SRS = Savannah River Site.
SST = single-shell tank.
WVDP = West Valley Demonstration Project.

Table B2. Site Waste Tank Lay-Up Requirements and Considerations (2 Sheets)

Requirements, Considerations, and Potential Issues		WVDP	Hanford Site	SRS	INEEL	ORR
Requirements	Ensure acceptable risks to workers and public	Establish safe operating envelope during lay-up. Maintain tank integrity. Prevent leaks to groundwater.	Minimize leaks to ground, air emissions. Maintain tank integrity. Minimize liquid ingress to tank.	Minimize leaks to soil and groundwater, air emissions. Maintain tank integrity. Minimize liquid ingress to tank.	Filter tank and vault exhausts as necessary; remote operation.	Store old and currently generated waste in highest integrity tanks.
	Comply with regulations, permits, and agreements	Table 1 regulatory drivers, plus DOE letter with Class C limits on tank cleanout.	Table 1 regulatory drivers, plus authorization basis, closure EIS, incidental waste determination.	Table 1 regulatory drivers, plus new tank closure EIS, incidental waste determination, impact of NRDC lawsuit (DOE O 435.1), land use implementation.	Table 1 regulatory drivers.	Table 1 regulatory drivers.
	Preserve future tank closure options	Preserve future options for tank decontamination and closure.	Consider the potential for secondary waste retrieval, remediation of contaminated soils, and remediation of ancillary equipment.	No tank closures until approval of new EIS.	Tank closure criteria awaiting DOE/RCRA documentation; HLW EIS.	Tank closures awaiting ROD and resolution of heel technical issues.
Considerations	Control life-cycle costs	Control capital and operating costs. Reduce tank surveillance and monitoring.	Reduce surveillance, monitoring, and maintenance requirements during lay-up period.	Reduce surveillance, monitoring, and maintenance requirements during lay-up period.	Utilize existing systems to greatest extent possible. Leave equipment in tanks when possible.	Close inactive tanks as soon as possible after waste acceptance criteria is satisfied.
	Gain stakeholder acceptance/ consensus	Involve key decision makers and stakeholders in planning/approval process.	Involve key decision makers and stakeholders in planning/approval process.	Involve key decision makers and stakeholders in planning/approval process.	Involve key decision makers and stakeholders in planning/approval process.	Involve key decision makers and stakeholders in planning/approval process.
	Minimize secondary wastes	Ensure secondary wastes can be readily disposed.	Use existing waste for retrieval. Dispose secondary wastes.	Ensure secondary wastes can be readily disposed.	Ensure secondary wastes can be readily disposed.	Ensure secondary wastes can be readily disposed.
	Use proven and accepted technologies	Include demonstrated construction methods.	Full-scale demonstration of retrieval technologies.	Modify techniques used to interim close two tanks.	Washball system to be used for cleanout; steam jets.	Modify solids removal methods from other sites.

Table B2. Site Waste Tank Lay-Up Requirements and Considerations (2 Sheets)

Requirements, Considerations, and Potential Issues		WVDP	Hanford Site	SRS	INEEL	ORR
Potential Issues	Specific to site	Ability to keep tank external surfaces dry. Ability to control oxygen (corrosion) in tanks. Effectiveness of groundwater barriers.	Dome loading, liner integrity analysis, leak detection; waste heel characterization/ inventory and classification; tank isolation, barriers; tank atmosphere control; retrieval performance; groundwater/vadose zone modeling, assessment; future land use.	Liner cracks; waste in annuli; waste in groundwater; ingress of groundwater into tanks.	Ability to demonstrate clean closure of tanks; in tank equipment; contaminated soil; source terms, groundwater modeling; future land use requirements; final treatment system.	Groundwater leaks into tanks; resin beads in the bottoms of some tanks.

DOE = U.S. Department of Energy.
EIS = environmental impact statement.
HLW = high-level waste.
INEEL = Idaho National Engineering and Environmental Laboratory.
NRDC = National Resources Defense Council.
ORR = Oak Ridge Reservation.
RCRA = Resource Conservation and Recovery Act.
ROD = Record of Decision.
SRS = Savannah River Site.
WVDP = West Valley Demonstration Project.

A list of candidate technologies and representative lay-up scenarios shall be prepared. To the extent possible, the strawman lists shall include scenarios solicited from the sites as well as from other appropriate sources (e.g., industry, literature searches, technology evaluations). The goal is to be able to thoroughly characterize each scenario by virtue of identified attributes. Each major site will be visited to confirm the requirements and discuss the strawman scenarios. The selected scenarios (and associated attribute lists) will provide the basis for application of the prioritization methodology to identify preferred interim tank waste storage configurations. The decision methodology tool demonstrated in fiscal year 2001 will be updated to provide easier use.

Currently-funded activities include the following.

- Review and revise the preliminary lists of tank lay-up requirements and alternatives developed in fiscal year 2001.
- Meet with end users and stakeholders at each site to gather information on needs and potential strategies.
- From identified site-specific needs, develop potential tank lay-up strategies for each site.
- Identify data gaps and uncertainties that can be used to drive additional technical evaluations and/or data collection to support ranking of candidate lay-up options for each site.
- Prepare a letter report documenting the above activities.

Proposed future activities include the following.

- Information will be collected to close as many information gaps as possible.
- A workshop will be held with key individuals from the waste tank sites to share information and to collectively use the prioritization method to determine preferred options for each site.
- An information center containing technical, regulatory, and site-specific information will be established to provide a resource for future tank lay-up planning and decisionmaking. This information center will be maintained and technical and decision support will be provided.

The questions to be used during site visits are provided in the Attachment to this document. The answers to these questions will serve as the basis for establishing the programmatic, regulatory, and technology development status and plans applicable to waste tank lay-up.

ATTACHMENT
QUESTIONS FOR SITE VISITS

ATTACHMENT
QUESTIONS FOR SITE VISITS

CLOSURE CRITERIA

What are your criteria for closure?

What regulations or agreements apply?

What other drivers do you have for lay-up and closure?

Is the attached list of lay-up criteria developed for the West Valley Demonstration Project applicable at your site?

What other site-specific criteria are there?

SCHEDULE

What is your schedule for

- Ceasing operational use?
- Decontamination?
- Final closure?

Do you envision a lengthy lay-up period between last operational use and final closure?

What issues might delay the closure schedule?

PLANS

What techniques do you intend to use for

- Cleaning?
- Lay-up?
- Closure?
- Monitoring and surveillance?

Can you envision cost savings and/or risk reduction during the lay-up period?

WASTE CHARACTERIZATION

What characterization of the residual waste has been done/is planned?

Are estimates of the composition of the residual waste after retrieval available?

Have any risk analyses been done for the residual waste?

TECHNOLOGY DEVELOPMENT

What relevant technology development activities are you conducting, sponsoring or aware of applicable to tank lay-up and closure?

TANK CHARACTERISTICS

What unique characteristics of your tanks influence lay-up and closure? Some considerations follow:

- What is the tank's leak history?
- What is the tank's operational history?
- How clean does it have to be, including removal of in-tank equipment and/or debris?
- What is the physical condition of the tank (e.g., dome, liner, shell)?
- What tank isolation activities are required?

WASTE STABILIZATION

Is additional removal of waste planned?

Is interim stabilization of the residual waste planned prior to final closure? If so, how?

SITE CHARACTERISTICS

What unique characteristics of your site influence lay-up and closure? Some considerations follow:

- What is the soil chemistry and conditions?
- What are the climatic conditions, especially rainfall?
- What is the proximity to aquifers, rivers, lakes, cities, etc.?
- What are the stakeholder issues, especially the public?
- What are the planned long-term land uses?
- What are the potentials for earthquakes and floods?
- What is the hydrology and geology of the area under and around the waste?

WEST VALLEY DEMONSTRATION PROJECT LAY-UP CRITERIA

The following criteria were developed to assess alternative approaches for interim lay-up of the West Valley Demonstration Project tanks. The primary objective for temporary tank lay-up is to maintain the tanks in a safe and stable configuration with minimum capital and operating costs until final closure is completed. Some of the decision criteria listed below are firm requirements (e.g., safety) while others are more value based. Do these also apply to your site, and are there other criteria or considerations at your site? Have you developed your own list of criteria, considerations, or requirements?

- **Comply with regulations and permit requirements –** All regulations and permit requirements must be complied with during the lay-up period.

- **Prevent release of tank contents to the groundwater –** There shall be no release of radioactive or hazardous materials to the groundwater. This is a consideration during any preparatory activities and during the lay-up period.

- **Ensure acceptable risk to workers and the public**

  – **Short-term risk:** The risks associated with the installation of any new equipment required for the selected option must be as low as reasonably achievable.

  – **Long-term risk:** The selected option should result in a reduced risk to workers and the public during the lay-up period.

- **Maintain integrity of the tanks –** The ability of the tanks to continue to contain the waste residual must be maintained. Corrosion of the tanks must be controlled, and the structural integrity of the tanks must be ensured.

- **Establish a safe operating envelope during temporary lay-up –** The operational requirements during the lay-up period must continue to be within safe limits, but reduced monitoring and surveillance should be considered in evaluating options.

- **Control costs**

  – Capital costs of new equipment or modifications to existing systems.
  – Routine operating costs during the lay-up period.

- **Utilize accepted methods and technologies –** The preferred option should be based on proven construction methods and demonstrated technologies.

- **Avoid production of secondary wastes during construction and operation –** Options that may produce secondary wastes, especially radioactive wastes that will require further treatment and disposal, should be generally avoided.

- **Preserve future options for decontamination and final closure –** The selected lay-up option must maintain the ability to sample the waste, perform additional waste removal, and complete additional decontamination of the tanks if necessary. Also, the lay-up option selected must not preclude candidate final closure options, such as in-place stabilization or complete tank removal.

- **Gain acceptance for lay-up –** The selected option must be acceptable to stakeholders. Any changes to permits or other requirements must be acceptable to regulatory agencies.

- **Reduce monitoring and surveillance –** Reductions in monitoring and surveillance, consistent with requirements, is desired.