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TFA TANKS FOCUS AREA

Multiyear Program Plan FY98-FY00

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Executive Summary

The U.S. Department of Energy (DOE) continues to face a major radioactive waste tank remediation problem with hundreds of waste tanks containing hundreds of thousands of cubic meters of high-level waste (HLW) and transuranic (TRU) waste across the DOE complex. Approximately 80 tanks are known or assumed to have leaked. Some of the tank contents have reacted to form flammable gases, introducing additional safety risks. These tanks must be maintained in a safe condition and eventually remediated to minimize the risk of waste migration and/or exposure to workers, the public, and the environment. However, programmatic drivers are more ambitious than baseline technologies and budgets will support. Science and technology development investments are required to reduce the technical and programmatic risks associated with the tank remediation baselines.

The Tanks Focus Area (TFA) was initiated in 1994 to serve as the DOE's Office of Environmental Management's (EM's) national technology development program for radioactive waste tank remediation.[a] The national program was formed to increase integration and realize greater benefits from DOE's technology development budget. The TFA is responsible for managing, coordinating, and leveraging technology development to support DOE's four major tank sites: Hanford Site (Washington), Idaho National Engineering and Environmental Laboratory (INEEL) (Idaho), Oak Ridge Reservation (ORR) (Tennessee), and Savannah River Site (SRS) (South Carolina). Its technical scope covers the major functions that comprise a complete tank remediation system: waste retrieval, waste pretreatment, waste immobilization, tank closure, and characterization of both the waste and tank with safety integrated into all the functions. The TFA integrates program activities across organizations that fund tank technology development EM, including the Offices of Waste Management (EM-30), Environmental Restoration (EM-40), and Science and Technology (EM-50).

The strategic intent of the TFA is to be risk-driven, fully integrated, fully leveraged, and responsive to user needs. Restated, TFA is focused on the following:

- working closely with EM-50 at DOE-Headquarters and each site, the tank site user programs (EM-30 and EM-40), and Site Technology Coordinating Groups (STCGs) to prioritize activities and make responsive technology investments that
  - Reduce the programmatic risks that 1) jeopardize the sites' ability to comply with regulatory or stakeholder drivers not part of the baseline plans or 2) limit the sites' ability to change their baselines in response to budget cuts
  - Reduce environmental, safety, and health risks involving environmental, worker, or public safety issues associated with managing or remediating tanks

[a] The DOE's Richland Operations Office serves as the lead field office and program manager of the TFA. The Pacific Northwest National Laboratory leads the TFA's technical team which consists of seven contractors and national laboratories.

- developing integrated solutions to obtain multisite benefit

- leveraging every available science and technology investment made by DOE to maximize the benefit to EM from all available resources and significantly reduce the overall cost of tank remediation

- working in partnership with site users and stakeholders (through STCGs) to ensure the implementation of technology investments.

Since it's inception, the TFA has made significant progress toward these goals. During FY95-97, the TFA addressed supernate treatment, waste characterization, waste retrieval, and tank closure issues at Hanford to support privatization efforts. At INEEL, the TFA supported data requirements to meet Title 1 Design per the Batt Agreement with the State of Idaho. At ORR, the TFA addressed characterization and waste retrieval issues for the gunite tanks and methods to process Melton Valley Storage Tanks (MVST) wastes to increase storage capacity. At SRS, the TFA addressed the closure of tanks and supported improvements to HLW processing.

The FY98-FY00 multiyear program plan (MYPP) documents the TFA's prior-year progress in more detail and, more importantly, identifies the proposed FY98 to FY00 investments to provide responsive and timely technical solutions to the current priority site user problems.

FY98-00 TFA Program Investments

The DOE-EM has set overall performance metrics for HLW and TRU waste for FY98-00. The EM-30 identifies metrics for the number of HLW canisters to be produced and the number of HLW tanks to be closed. EM-40 identifies metrics for the number of radioactive tanks cleaned and ready for closure. The TFA supports these measures by providing technical solutions to the key problems associated with meeting the DOE-EM metrics. Technical solutions that can provide complex-wide value are emphasized. The DOE's tank remediation problems and TFA's FY98-FY00 technical solutions are encompassed within the functional areas of waste mobilization and retrieval, tank closure, waste pretreatment, and waste immobilization. Safety, characterization, and monitoring requirements are integrated into the technical solutions in each of these functional areas.

Waste Mobilization and Retrieval

To meet processing, cleaning, and closure requirements, tank waste must be removed from the tanks. To remove the waste, saltcake must be dissolved and pumped to process tanks, sludge must be mobilized and slurried to process tanks, and mixtures of saltcake, sludge, and other materials, including zeolites and debris, must be removed for further processing. Moreover, the removal processes must be monitored to ensure wastes meet process feed specifications and must be efficient to avoid adding excess water to the system, that adds to processing cost and can be a leakage concern in tanks of questionable integrity. Finally,

waste must be retrieved in a manner that controls conditions that could lead to unwanted plugging of transfer pipes. In FY98-00, the TFA will provide technical solutions to facilitate solving the specific problems at Hanford, ORR, and SRS to meet the waste mobilization and retrieval requirements. Specifically, the TFA will support privatization phase I retrieval needs and phase II retrieval benchmarking at Hanford, retrieval of sludge and saltcake to support Defense Waste Processing Facility (DWPF) processing goals at SRS, and retrieval and transfer of wastes to Melton Valley Storage Tanks to support processing at ORR.

Tank Closure

To meet tank cleaning and closure goals set by DOE-EM, the sites require solutions that obtain data needed to negotiate closure criteria with local regulators. Sites also require cleaning methods that do not introduce excess water or chemicals that have undesirable effects, such as foaming, on downstream processes. Finally, sites require stabilization technologies to encapsulate or immobilize residual waste as well as provide structural stability and isolation of the tank. In FY98-00, the TFA will provide technical solutions to facilitate solving the specific tank closure challenges at Hanford, ORR, and INEEL. Specifically, TFA will support the Hanford Tanks Initiative (HTI) in establishing retrieval performance objectives for future closure decisions at Hanford, the Gunite and Associated Tanks (GAAT) closure efforts at ORR, and waste tank residuals sampling to help establish a basis for tank retrieval and processing; and closure at INEEL.

Waste Pretreatment

To meet the DOE-EM goal of producing HLW canisters that meet performance requirements, technology is required to pretreat the waste feed to immobilization technologies. Additionally, significant cost reductions for disposing of immobilized waste can be achieved by improving the pretreatment processes so that fewer HLW canisters and less volume of low-level waste (LLW) waste form results. In FY98-00, the TFA will provide technical solutions to facilitate solving the specific pretreatment problems at Hanford, ORR, INEEL, and SRS. Specifically, the TFA will support processing to ensure feed delivery for phase I privatization and performance data for the phase II strategy at Hanford, solid-liquid separation processing to ensure wastes meet privatization feed specifications at ORR, performance data development required for the Environmental Impact Statement (EIS) and Title I design at INEEL, and processing to reduce LLW volume and improve cesium removal at SRS.

Waste Immobilization

To meet HLW canister and remote handled (RH)-TRU tank waste package production requirements, existing immobilization processes must be able to handle a broader envelope of waste streams than currently available. Moreover, significant reductions in cost can be achieved if fewer canisters can be produced per volume of waste processed. In FY98-00, the TFA will provide technical solutions to facilitate solving the specific problems at Hanford, ORR, INEEL, and SRS. Specifically, the TFA will support waste acceptance testing for

phases I and II privatization and performance data for the phase II strategy at Hanford, grout and glass waste form performance data for privatization efforts at ORR, formulations and melter materials selection for the EIS and Title I design at INEEL, and enhanced DWPF processing to meet full production capability at SRS.

TFA Program Development

The TFA pursues a phased management and technical strategy to meet its strategic intent described earlier. The program focused initially on technologies that could be rapidly deployed or meet near-term needs at multiple sites under multiple possible baselines (e.g., privatization). In FY96, four technical goals were developed for the TFA to augment the strategic intent and help guide the program to both near-term, mid-term, and targeted longer-term investments. These technical goals were to

- Demonstrate, deploy, and provide performance data for four systems to meet EM's FY00 tank waste retrieval requirements.
- Provide tank waste treatment technologies that can efficiently pretreat and immobilize 80% of HLW.
- Demonstrate compact processing units (CPU) for HLW treatment and immobilization as a cost-effective alternative to large-scale facilities.
- Provide subsystems necessary to support the closure of 16 radioactive waste tanks: Hanford (2), ORR (10), and SRS (4).

The FY97-99 plan (TFA 1996) incorporated these technical goals and included an intentional focus on problems and site needs associated with site baselines to enhance user commitment and technology deployment opportunities. The current FY98-00 MYPP continues this focus, but presents a much more integrated TFA program. The integration more tightly binds the TFA to other EM-50 resources, such as crosscutting programs, Industry Programs, International Programs and University Programs. More importantly, this plan is also the result of closer ties with the four major tank sites.

The process used to develop and define this more integrated TFA technical program is shown in Figure ES.1. The TFA receives input throughout this process from stakeholders that include a User Steering Group (USG), a TFA Technical Advisory Group (TAG), and DOE's TFA Management Team. The USG is comprised of senior managers from the sites' contractor tank remediation programs. The TAG is comprised of technical experts from national laboratories, industry, and universities. The TFA Management Team is comprised of representatives from DOE-Headquarter's EM-30, EM-40, EM-50 organizations, and EM-30 field office organizations for each site.

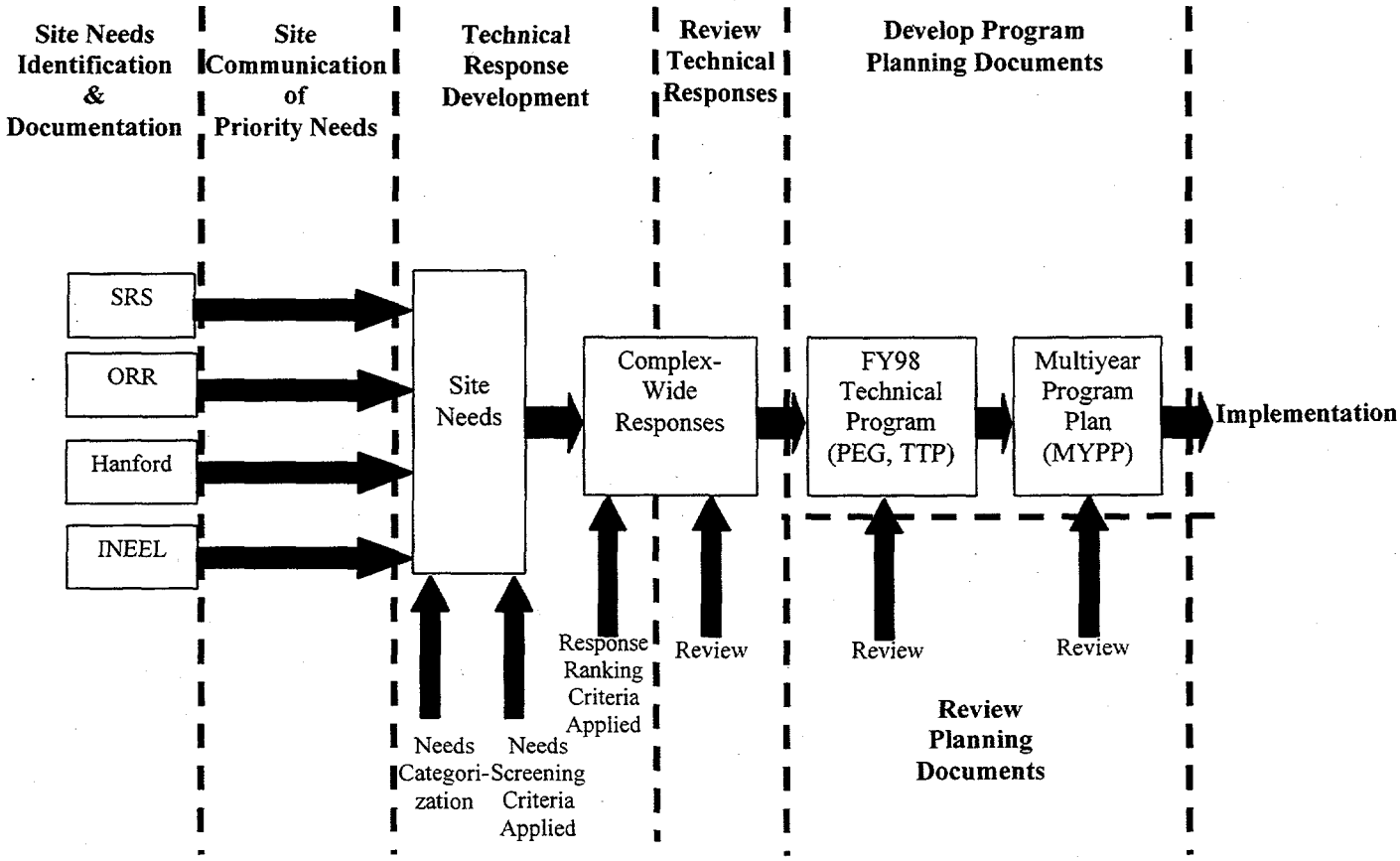


Figure ES.1. Tanks Focus Area Program Development Process

The program development process has six major steps:

- **Site Needs Identification & Documentation** (October 1996-December 1996) - Each site used its own process. Generally, sites relied on or involved their STCGs to identify and document tank-related needs.

- **Site Communication of Priority Needs** (December 1996-January 1997) - The TFA Site Representatives agreed to describe and submit needs using a new STCG-developed template. Proper completion of the template greatly improved the quality of the input required for TFA's comprehensive needs analysis. In addition, fully completed templates permitted the TFA to develop higher quality technical responses sooner than in the past.

- **Technical Response Development** (January 1997-March 1997) - Technical response development began with the analysis and categorization of each need. Upon receipt by TFA, each need was screened, reviewed for completeness, tentatively placed within the TFA problem element structure, and assigned to a TFA Technology Integration Manager according to function. The functions are safety, characterization, pretreatment, immobilization, retrieval, and closure. Incomplete needs templates were referred back to the submitting site for completion before a technical response was developed.

- **Review Technical Responses** (mid-February to mid-April 1997) - The TFA worked to obtain site input and consensus on the technical responses. The TFA was prepared to best accommodate each site's situation to obtain consensus, whether by telephone coordination, site visits, or other means. Reviews were conducted by the DOE Site Representatives, USG, and TFA TAG.

- **Develop Program Planning Documents** (June to mid September 1997) - Successful completion of the previous four steps significantly simplified the preparation of follow-on program development documents. These included development of the FY99 Internal Review Budget, FY98 Program Execution Guidance, and development of this MYPP. In the past, these program documents were based largely on technical responses to the needs without sufficient time for complete site buy-in. In this year's process, full site buy-in was obtained throughout the entire program development process.

- **Review Planning Documents** (June to mid-September 1997) - With full site buy-in already accomplished, the only review requirement expected was to accommodate late program adjustments not coordinated during earlier program development steps. This year's MYPP will receive an additional review by the HLW Steering Committee.

The results of this program development process include a prioritized, multiyear plan to address the priority needs of the users. Table ES.1 summarizes the users' problems and TFA's planned activities in response. The TFA strives to ensure each activity is integrated with other related technical activities funded by EM-30, EM-40, or EM-50 to maximize the

benefit from DOE's investments. The TFA's planned activities are communicated to EM-30 and EM-40 early enough to help the user programs complete their annual planning process. Table ES.2 shows the estimated leveraged funding the TFA has identified from all known, relevant sources for each of the problem elements described in Table ES.1.

The TFA worked in close partnership with the sites in a team effort to develop technical responses to priority site needs, prioritize those responses, and select performers. With that, the TFA believes it has the widespread support of the sites for the program summarized within this document.

Table ES.1. Scope of Recommended Tanks Focus Area Technical Program

Problem Element	Problem Statement	Path to Solution
1.1 Store Waste		
1.1.1.1 Monitor Tank Integrity	Real time corrosion inhibitor and corrosion monitoring methods are needed to provide early detection of potential problems that may lead to leakage or structural failure. There is a need to perform nondestructive examination of tank walls to determine structural integrity. Current methods are limited to contact examinations and usually require a cleaned surface and coupling between the head and structure being inspected.	• Develop and deploy an LDUA-delivered end effector for nondestructive examination inspection in Hanford's waste tanks. • Identify and evaluate monitors for $NO_3^-/NO_2^-/OH^-$ to maintain corrosion inhibitor concentrations at SRS. • Demonstrate and transfer electrochemical corrosion probe to SRS and Hanford.
1.1.2 Ventilate Tanks	Waste tank ventilation is necessary to maintain safe operating conditions within the tank farm. However, baseline ventilation systems comprise energy- and maintenance-intensive components. For example, frequent change-out of disposable HEPA filters increases the cost and risk of maintaining safe tank operations.	• Design, select, and demonstrate passive ventilation systems to reduce the O&M costs of active ventilation systems at SRS. • Design and procure regenerable (i.e., washable) sintered metal filter systems to replace HEPA filters within tank ventilation systems at SRS to reduce worker risk and cost.
1.1.3.1 Characterize Waste In Situ	Designing and deploying effective waste retrieval systems for tank wastes requires knowledge of the waste characteristics, such as the volumes and interface between supernate, sludge, and/or hard heel. Methods to map the sludge or heel level are needed for tanks where the bulk supernate remains, to allow for design of the retrieval system and retrieval strategy before supernate removal.	• Develop and demonstrate a sludge mapping tool to measure the volume of sludge present in tanks before and after supernate retrieval at ORR.
1.1.4.2 Reduce Recycle Streams	Tank farms are still receiving wastes even though many major mission operations have ceased at most of the sites. Some of these wastes result from tank-to-tank transfers to solve waste storage problems or from tank waste processing operations. Removal of dilute concentrations of problem constituents could allow these wastes to be discharged rather than being recycled to the tank farms for subsequent costly processing.	• Develop specifications and procure a commercial system for adaptation to the treatment of the Defense Waste Processing Facility recycle stream. • Demonstrate the pilot system at SRS.

Table ES.1. (contd)

Problem Element	Problem Statement	Path to Solution
1.2 Process Waste		
1.2.1.2 Mobilize Bulk and Heel Wastes	The DOE complex has horizontal and vertical cylindrical steel and concrete waste storage tanks that require remediation. Removal of bulk saltcake and sludge, saltcake heels, hard sludge heels, and possibly debris will be required. Alternative approaches to the hydraulic mining baseline are required for retrieval of the hard sludges, or bulk waste retrieval in leaking tanks where water use is restricted, as well as removal of debris and contaminated floor and wall segments. There is also a need for technical support for producing functions and requirements documents and prototypic hardware to allow sites to procure the right equipment.	• Deploy pulsed air and improved jet pump systems to support ORR GAAT retrieval and waste conditioning operations with the MLDUA, Houdini, and Confined Sluicing End Effector. • Demonstrate fluidic pulse jets for sludge mobilization in ORR Bethel Valley Evaporator Service Tanks. • Design and deploy the extendible nozzle/borehole miner to support retrieval of sludges from the ORR Old Hydrofracture Tanks. • Demonstrate and deploy salt dissolution methods for tank annuli and modified density gradient salt dissolution for bulk saltcake at SRS. • Develop performance specifications and procure and test commercial systems for heel retrieval at SRS and Hanford. • Retrieve C-106 heel to support retrieval performance objectives development.
1.2.1.4 Transfer Waste	Waste transfer operations are required after retrieval to support more efficient waste storage, to support a retrieval operation, or staging of wastes for subsequent blending or pretreatment. During transfers, pipeline plugging has occurred and can result in very costly delays and intensive efforts to mitigate the plugging. Pipeline unplugging techniques are needed to mitigate future problems safely and cost effectively.	• Adapt and test commercial systems for pipeline unplugging, and perform side-by-side testing to evaluate the merits of multiple systems. • Develop and deploy waste conditioning CPU - ORNL • Evaluate the effects of physical and chemical conditions on waste rheology and transfer for Hanford, ORR, and SRS waste types and test commercial methods for unplugging transfer lines.
1.2.1.5 Detect and Mitigate Leaks	Measurement of waste tank liquid levels can have accuracies on the order of thousands of liters. Improved methods for leak detection are needed to prevent unplanned release of radioactive waste in the event leakage occurs during retrieval. Leakage during sluicing and other types of waste removal will be an issue with states, regulatory agencies, stakeholders, and sites. Two general types of leak prevention technologies, repair and mitigation, need to be investigated and alternatives evaluated.	• Evaluate state-of-the-art technologies in leak mitigation and repair within DOE, U.S. industry, and internationally. • Develop multiyear program to develop, test, and demonstrate systems for leak mitigation and repair based on user input on performance requirements and the current technology status. • Develop improved tank evaporation monitoring to reduce the uncertainty of current water balance measurements.
1.2.1.6 Monitor & Control Retrieval Process	The physical and chemical properties of the retrieved waste must meet certain operational requirements for retrieval and pretreatment operations to be successful. Transfer line pluggage is a concern for operations, and particle size, weight percent solids, and chemistry changes occurring during retrieval impact the efficiency of the downstream pretreatment operations. Sampling, analysis, and monitoring (e.g., sensors) that can provide these data are needed.	• Develop a multi-level sampling device with at-tank analysis to support feed staging for Phase I privatization at Hanford. • Prepare and downselect several types of on-line slurry monitors for testing and hot deployment at ORR.

Table ES.1. (contd)

Problem Element	Problem Statement	Path to Solution
1.2 Process Waste		
1.2.2.1 Calcine Waste	The INEEL sodium-bearing waste is not compatible with the current fluidized bed calcination flowsheet at 500°C because of incomplete conversion of the nitrates to oxides and the formation of agglomerated particles in the calcine. Alternatives include high temperature processing and sugar additive calcination to improve denitration. In addition, the waste processing baseline plan for INEEL includes a separations flowsheet option that is being pursued, and requires dissolution of calcines before radionuclide separation. Therefore, both technical advancements to support future calcination and developments of methods to dissolve existing calcine are required to meet the processing schedule for INEEL.	• Optimize the calcining flowsheet to handle sodium-bearing wastes through pilot-plant studies. • Evaluate the chemistry and dissolution behavior of calcines and bench test preferred methods to support flowsheet development.
1.2.2.3 Prepare Retrieved Waste for Transfer and Pretreatment	Physical and chemical properties of tank waste can impact the efficiency of pretreatment. Various chemical combinations can lead to gelation or precipitation, which will adversely impact processing. A better understanding of sludge and saltcake chemistry and its impact on dissolution rates, pipeline transfers, and mixing operations is needed.	• Evaluate saltcake dissolution and concentrate re-precipitation phenomena in complex solutions to upgrade thermodynamic models to support retrieval and storage operations at Hanford.
1.2.2.4 Clarify Liquid Stream	Baseline technology for solid-liquid separation does not appear adequate for many of the tank pretreatment waste streams. Testing of alternative filter systems is required to support the separation of undissolved solids from the sodium-bearing and dissolved calcine wastes at INEEL and various LLLW streams at ORR including TRU sludges.	• Obtain performance data on cross-flow filtration to remove undissolved solids from acid waste and to evaluate regeneration with back pulse or non-acid wash at INEEL. • Obtain operational experience on a larger scale system by preparing a hot demonstration on wastes for transfer to Melton Valley Storage Tanks (MVST) at ORR.
1.2.2.5 Remove Radionuclides	Cesium Removal from Alkaline Wastes: Alternative cesium removal technologies are desired for SRS to backup the baseline in-tank precipitation process and allow potential improvements in efficiency and life-cycle costs. For ORR, performance and cost data from actual processing is needed to ensure that deployment of cesium removal using CST is appropriate. Radionuclide Removal from Acid Wastes: Treatment technologies applicable to transuranic elements including strontium, technetium, and cesium in INEEL waste streams must be developed and tested to provide cost and performance data for final baseline technology selection.	Cesium Removal from Alkaline Wastes: • Complete demonstration and transfer the CST removal system for use on cesium at ORR. • Evaluate crystalline silicotitanate and other sorbents to augment the current tetraphenylborate process or provide Cs removal for the DWPF recycle for SRS. Radionuclide Removal from Acid Wastes: • Select appropriate separations processes for TRU, technetium, strontium, and cesium removal. • Test and demonstrate methods for TRU, technetium, strontium, and cesium removal over a 3-year period. • Produce performance and cost data to support INEEL decision on their baseline radionuclide separation unit operations.

Table ES.1. (contd)

Problem Element	Problem Statement	Path to Solution
1.2 Process Waste		
1.2.2.7 Process Sludge	Sludges at SRS, Hanford, and ORR will require processing to remove nonradioactive constituents that either adds to the volume of the resulting HLW (e.g., aluminum) or impacts immobilization processing (e.g., chromium, technetium, or phosphate). Technical problems and issues exist in three areas of sludge processing: performance data on the baseline enhanced sludge washing system, sludge washing chemistry, and continuous sludge processing.	• Evaluate caustic dissolution behavior of various Hanford sludge components to support the March 1998 Tri-Party Agreement milestone and to recommend processing parameters for Phase I privatization (extended quantity order) and Phase II RFP decisions. • Evaluate chromium removal performance during sludge washing and identify methods (e.g., oxidative leaching and caustic leaching) to improve chromium removal. • Study dilution, leaching, and washing of Hanford sludges to identify the operating envelope required to minimize solids formation problems during pretreatment.
1.2.2.8 Prepare Pretreated Waste for Immobilization	Pretreated alkaline supernate containing large volumes of sodium nitrate is sent to LLW immobilization processes. Nitrate concentration impacts the volume of LLW, because it is one of the chemical species driving waste form performance requirements. In addition, current separations and LLW feed preparation at SRS leaves a waste stream with a higher water content than is necessary for effective saltstone production. A reduction in this water content could significantly reduce the volume of LLW saltstone formed while maintaining a quality LLW product.	• Evaluate salt splitting and membrane separation for caustic recovery for use at SRS and Hanford and explore commercial equipment for design and cost analysis. • Design and procure commercially available equipment for out-of-tank evaporation of the saltstone feed stream at SRS to decrease the volume of immobilized LLW produced.
1.2.3.1.3 Immobilize LLW Stream	Disposal of low-activity tank wastes is being approached very differently at individual DOE sites and, in some cases, even within a single site. Specific technical issues and needs exist at the sites for selection of the most appropriate and acceptable waste forms.	• Develop specifications/functional requirements for grout waste formulations for INEEL and grout and glass waste forms for ORR. • Test and evaluate grout formations for INEEL's high aluminum, zirconium, and sodium wastes. • Demonstrate and evaluate grout and glass waste forms for ORR.
1.2.3.2 Process HLW	The baseline technology for HLW processing is vitrification at all of the tank sites. At SRS, methods that can reduce the cost of ongoing operations are needed. Cost reduction can occur through optimization of waste loading that reduces the number of glass logs produced and improvements in process equipment and materials of construction that reduce maintenance and downtime by reducing corrosion or other materials failure problems. At Hanford, optimized waste loading and melter selection, especially with regard to high chromium wastes, are considerations for developing the baseline to support Phase II privatization. At INEEL, waste formulation for sodium-bearing waste and calcined wastes followed by melter testing is needed to meet an accelerated schedule for the ROD, and the FY00 Title 1 Design schedule.	• Identify methods to optimize waste loading for components such as iron, aluminum, silicon, zirconium, and alkali cations in SRS and Hanford wastes and determine solubilities in glass of minor components such as chromium, phosphate, halides, technetium, and actinides. • Establish glass compositions for INEEL's sodium-bearing and calcined wastes to avoid highly corrosive environments and produce acceptable waste forms. • Test melters for use at INEEL to ensure compatibility of wastes and materials of construction. • Develop and demonstrate equipment improvements such as melter pour spout and level and density monitors for DWPF process tanks to reduce downtime and increase throughput.

Table ES.1. (contd)

Problem Element	Problem Statement	Path to Solution
1.3 Store Waste Forms and Close Tanks		
1.3.1 Close Tanks	Closure of radioactive waste tanks has become a key element in the tank sites' baseline plans for reducing mortgage and accelerating cleanup. SRS is actively closing tanks in FY97, while ORR and Hanford are preparing for future tank closure activities through the GAAT Treatability Study and the Hanford Tanks Initiative, respectively. INEEL is exploring an accelerated schedule for tank closure and will be sampling tank residuals to support future closure decisions. Tank closure activities require sampling or characterization of tank residuals, definition of closure criteria (i.e., asking the question, "how clean is clean?"), and stabilizing the tank for closure. Strategies and methods for accomplishing these activities are needed.	Sample and Characterize Heels/Residuals • Deploy the LDUA at INEEL to sample tank residuals and support strategy development for accelerated tank closure. • Develop and demonstrate vadose zone characterization tools for the cone penetrometer to support tank farm closure performance evaluations and development of retrieval performance criteria within the Hanford Tanks Initiative. • Deploy the LDUA with gripper end-effector and sampling devices to sample off-riser tank residuals in 104-AX and 106-C and support retrieval performance criteria development. Define Closure Criteria • Develop retrieval performance objectives to support the termination of tank closure requirements. Stabilize Tank for Closure • Develop and deploy tools using the LDUA to isolate and plug tank penetrations (e.g., piping) and develop, test, and deploy grout formulations and jet grouting techniques to stabilize gunite tanks at ORR.
1.3.2 Dispose of LLW	Product quality assurance is a necessary step in the LLW immobilization process. While product quality assurance is well established for the HLW glass and LLW saltstone at SRS, LLW glass for Hanford still requires product quality assurance methods and waste form performance testing to allow for LLW disposal preparations and receipt of LLW glass product from the privatization vendors.	• Develop an integrated plan for evaluating disposal site performance criteria, waste form performance, and product quality assurance data and methods to support Hanford Phase I privatization and ORR LLW immobilization decisions. • Develop waste form standards and test methods, and adapt and demonstrate industrial methods for product quality assurance to allow DOE to accept waste product from privatization vendors.

DOE	U.S. Department of Energy	MLDUA	Modified Light-Duty Utility Arm
DWPF	Defense Waste Processing Facility	MVST	Melton Valley Storage Tanks
GAAT	gunite and associated tanks	O&M	operations and maintenance
HEPA	high-efficiency particulate air	ORR	Oak Ridge Reservation
HLW	high-level waste	RFP	request for proposal
INEEL	Idaho National Engineering and Environmental Laboratory	ROD	record of decision
LDUA	Light-Duty Utility Arm	SRS	Savannah River Site
LLLW	liquid low-level waste	Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
LLW	low-level waste	TRU	transuranic

Table ES.2. Recommend

Problem Element	Problem Element Title	FY98$			
		TFA	EM-50 Ind/Int/ Univ	EM-50 Cross Cut	EM 30-
1.1.1.1	Monitor Tank Integrity	395	400	197	
1.1.2	Ventilate Tanks	50	500	0	
1.1.3.1	Characterize Waste In Situ	0	0	0	
1.1.3.3	Analyze Waste	0	0	0	
1.1.4.1	Reduce Source Streams	0	0	0	
1.1.4.2	Reduce Recycle Streams	0	0	125	
1.2.1.2	Mobilize Bulk and Heel Wastes	3775	50	2100	97
1.2.1.3	Mix Waste	0	0	0	
1.2.1.4	Transfer Waste	0	0	0	
1.2.1.5	Detect and Mitigate Leaks	0	0	0	
1.2.1.6	Monitor & Control Retrieval Process	500	0	600	
1.2.1.7	Integrate Retrieval and Pretreatment Technology Systems	0	0	0	
1.2.2.1	Calcine Waste	350	0	0	7
1.2.2.2	Dissolve Waste	0	0	0	4
1.2.2.3	Prepare Retrieved Waste for Transfer and Pretreatment	425	150	0	
1.2.2.4	Clarify Liquid Stream	725	0	0	6
1.2.2.5	Remove Radionuclides	785	0	2080	8
1.2.2.7	Process Sludge	2625	0	350	
1.2.2.8	Prepare Pretreated Waste for Immobilization	525	1000	300	
1.2.3.1.3	Immobilize LLW Stream	2050	200	0	10
1.2.3.2.1	Monitor & Control HLW Immobilization Process	50	200	0	
1.2.3.2.3	Prepare Sludge Feed	0	0	0	
1.2.3.2.4	Immobilize HLW Stream	1660	0	0	8
1.3.1	Close Tanks	0	0	0	
1.3.1.2	Characterize Heels	2300	0	0	4
1.3.1.3	Define Closure Criteria	7000	0	600	52
1.3.1.7	Stabilize Tank for Closure	1270	0	0	45
1.3.2.1	Monitor Waste for Acceptance	600	0	0	
1.3.2.2	Determine Performance of Waste Form	200	0	0	
Totals:		**31500**	**2500**	**6352**	**243**

Notes: 1) EM-50 Ind/Int/Univ = Industry, International, University; EM-50 Cross Cut = Sum of Characte Crosscutting Program, and Robotics Crosscutting Program.

2) EM-30 and EM-40 funding data based on available information.

3) All funding estimates are for planning purposes only and are not official funding information.

4) Does not include Environmental Management Science Program (EMSP) or Technology Deploy

5) TFA totals include annual costs for technical strategy development, technology delivery, and p

Technical Program Budget ($K)

	FY99$					FY00$					
FY98 Total	TFA	EM-50 Ind/Int/ Univ	EM-50 Cross Cut	EM 30-40	FY99 Total	TFA	EM-50 Ind/Int/ Univ	EM-50 Cross Cut	EM 30-40	FY00 Total	Grand Total
1067	750	425	0	0	1175	450	0	0	0	450	2692
550	600	1125	0	0	1725	600	1075	0	0	1675	3950
0	750	0	0	0	750	700	0	0	0	700	1450
0	1100	0	0	0	1100	750	0	0	0	750	1850
0	525	0	0	0	525	475	0	0	0	475	1000
125	400	500	0	0	900	600	525	0	0	1125	2150
15625	4325	200	0	0	4525	3525	100	0	0	3625	23775
0	900	0	0	0	900	900	0	0	0	900	1800
0	450	900	0	0	1350	650	1525	0	0	2175	3525
0	250	400	0	0	650	300	500	0	0	800	1450
1100	950	500	0	0	1450	950	425	0	0	1375	3925
0	300	0	0	0	300	500	0	0	0	500	800
1080	600	0	0	700	1300	400	0	0	700	1100	3480
414	420	0	0	419	839	600	0	0	643	1243	2496
575	450	0	0	0	450	0	0	0	0	0	1025
1405	1575	0	0	430	2005	1400	0	0	592	1992	5402
3665	1170	0	0	1375	2545	700	0	0	1375	2075	8285
2975	4500	0	0	0	4500	2600	0	0	0	2600	10075
1825	1430	1550	0	0	2980	1600	0	0	0	1600	6405
3250	900	0	0	1000	1900	1150	0	0	1000	2150	7300
250	250	200	0	0	450	350	0	0	0	350	1050
0	200	0	0	0	200	400	0	0	0	400	600
2460	1905	0	0	900	2805	2450	0	0	1100	3550	8815
0	1000	0	0	0	1000	1500	0	0	0	1500	2500
2700	400	0	0	0	400	0	0	0	0	0	3100
12805	10400	0	0	8000	18400	11900	0	0	7000	18900	50105
5770	800	0	0	0	800	150	0	0	0	150	6720
600	1000	0	0	0	1000	1000	0	0	0	1000	2600
200	1100	0	0	0	1100	400	0	0	0	400	1700
64656	**45550**	**5800**	**0**	**12824**	**64174**	**43150**	**4150**	**0**	**12410**	**59710**	**188540**

zation, Monitoring, and Sensor Technology Crosscutting Program, Efficient Separations and Processing

ient Initiative (TDI) funding. See individual problem elements in Appendix B.
gram management of $6.15M.

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Section 1 - Introduction

The Tanks Focus Area (TFA) Multiyear Program Plan (MYPP) presents the recommended TFA technical program. The recommendation covers a 3-year funding outlook (FY98-FY00), with an emphasis on FY98 and FY99. In addition to describing the processes used to develop the program (Section 2), this document also defines the technical strategies and the recommended TFA program (Section 3), the programmatic and implementation strategy for the program (Section 4), the references used to write this report (Section 5), data on the U.S. Department of Energy (DOE) tank sites (Appendix A), details on baseline assumptions and the problem elements (Appendix B), a summation of other TFA support provided by the DOE (Appendix C), a TFA "who's who" directory (Appendix D), and a glossary (Appendix E).

1.1 Program Background

The DOE faces a major radioactive waste tank remediation problem. Hundreds of tanks currently store hundreds of thousands of cubic meters of high-level waste (HLW) and transuranic (TRU) waste across the DOE complex. Most have significantly exceeded their life spans. Approximately 80 tanks are known or assumed to have leaked. In addition, some of the tank contents have reacted to form flammable gases, introducing additional safety risks. These tanks must be maintained in a safe condition and eventually remediated to minimize the risk of migration and exposure to workers, the public, and the environment. However, regulatory drivers are more ambitious than baseline technologies and budgets will support.

The 272[a] tanks that are in the TFA's purview are located at the four major DOE tank sites: Hanford Site, Richland, Washington; Idaho National Engineering and Environmental Laboratory (INEEL), Idaho Falls, Idaho; Oak Ridge Reservation (ORR), Oak Ridge, Tennessee; and Savannah River Site (SRS), Aiken, South Carolina. The approximately 378,000 m^3 of tank waste exist in different forms, and the constituents vary across the sites and across the tanks at each site. The tanks also differ in structure, construction, and capacity. The technical risks of remediation are complicated by programmatic, institutional, and regulatory issues that also vary across the sites.

The DOE's Office of Environmental Management (EM) had an estimated FY97 budget of about $62 million for technology development to remediate tank waste. This money is funded out of 11 organizations and supports several hundred separate activities addressing a variety of problems across the four tank sites. The TFA's challenge is to influence, coordinate, and integrate this tank waste remediation technology development program that

[a] As of July 1997, Tank 20 at SRS was officially closed in a joint EM-30 and EM-50 effort. The total number of remaining tanks within the TFA purview is now 272.

solves key problems identified by the user organizations. Each site has specific requirements, yet, due to limited funding, technology development progress at any one site must be leveraged throughout the DOE complex. The magnitude of this challenge is viewed better when considering the tank waste remediation life-cycle costs at the four sites. In 1997 constant dollars, the total cost is nearly $50 billion. Figure 1.1 shows this distribution graphically, with details for each site presented in Appendix A.

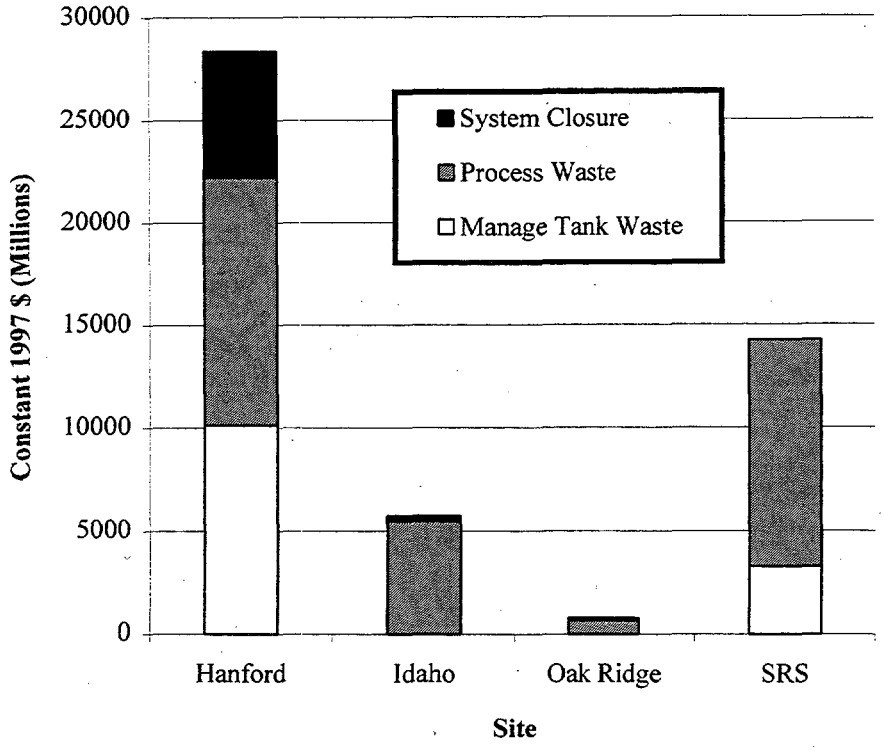


Figure 1.1. Tank Waste Remediation Life-Cycle Costs by Site

1.2 New Approach to Technology Development

Before FY95, responsibility for remediating DOE's tanks and for developing supporting technologies was spread across multiple organizations and sites within the DOE complex. In January 1994, DOE issued an action plan establishing a new approach for solving complex remediation problems, including the HLW and TRU waste tank problem. On April 1, 1994, DOE issued a call for proposals on approaches for transitioning tank technology development from a site-based effort to one with a national focus.

A team of seven contractors and national laboratories responded to the call for proposals and was awarded responsibility for implementing the new approach for tanks. In this effort, Pacific Northwest National Laboratory serves as the lead technical organization. Presently,

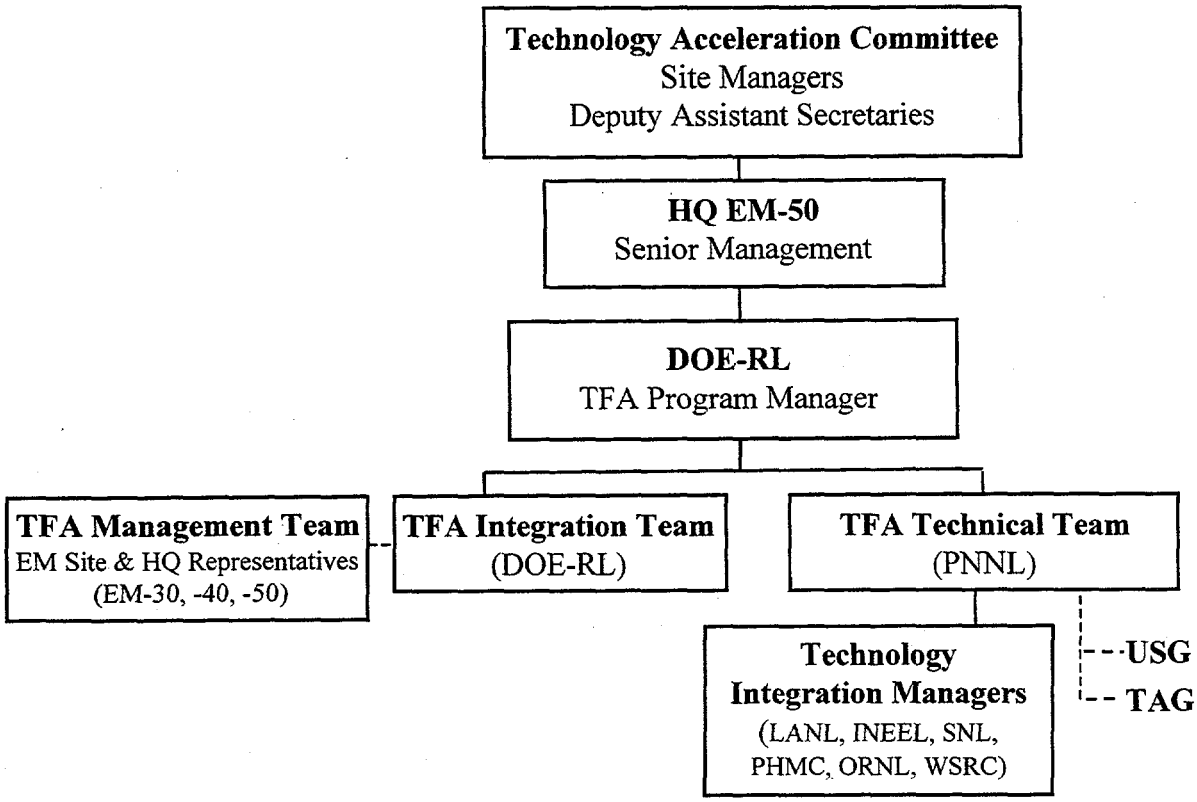


Figure 1.2. Tanks Focus Area Organization

this team is composed of INEEL, Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL), Sandia National Laboratories (SNL), Westinghouse Savannah River Company (WSRC), and Project Hanford Management Contractors (PHMC). The DOE's Richland Operations Office (RL) serves as the lead field office and program manager of this team, coordinating the efforts of other site field activities through the TFA Management Team and Site Technology Coordination Groups (STCGs). See Figure 1.2, Tanks Focus Area Organization, and Appendix D, Who's Who.

The Technical Team is guided by the User Steering Group (USG) composed of senior managers from each of the technical team partners; there are user members from the four tank sites and three non-user members representing the laboratory. The technical program is reviewed by the TFA Technical Advisory Group (TAG), which is composed of technical experts from across the country.

The DOE-RL leads the TFA Management Team, which prioritizes the technical program and ensures TFA technology is integrated into the site plans. This management team consists of DOE Headquarters and Site Representatives from each of the user programs. These representatives are also responsible for informing their line management of TFA activities and accomplishments, including members of the High-Level Waste Steering Committee.

The TFA began operations in October 1994. Its mission is to manage the development and demonstration of technologies using an integrated approach to safely and efficiently accomplish tank waste remediation across the DOE complex. Successful solutions will reduce technical, programmatic, or environmental, safety, and health risk and reduce the overall cost of tank remediation.

The TFA is responsible for technology development to support DOE's four major tank sites: Hanford Site, INEEL, ORR, and SRS. Its technical scope covers the major functions that comprise a complete tank remediation system: safety, characterization, retrieval, pretreatment, immobilization, and closure. The TFA integrates program tank-related activities across all organizations that fund tank technology development within EM, including the Offices of Waste Management (EM-30), Environmental Restoration (EM-40), and Science and Technology (EM-50). In the future, the TFA will further integrate activities across and beyond the DOE complex as it strives to identify and leverage all available resources to address DOE's tank waste remediation needs.

1.3 TFA Strategies and Goals

The TFA has greatly increased awareness of DOE complex-wide tank waste remediation needs, the state of technologies to satisfy those needs, and the roles played by various users, developers, and producers of technology. Through this deeper awareness, the TFA developed both the technical and programmatic strategies and goals that appear in this MYPP.

1.3.1 Technical Strategies and Goals

Technical strategies exist for each major problem area intended for direct TFA funding as well as leveraged funding. The strategies consider work by others that the TFA may leverage (Section 3). The TFA's technical goals strive to meet the challenges of providing 1) waste retrieval systems, 2) pretreatment and immobilization technologies, 3) support to tank closure activities, and 4) demonstration of compact processing units. These technical goals ensure that EM meets its goals for processing waste (e.g., number of canisters per year) and cleaning and closing tanks (e.g., number of tanks closed per year).

1.3.2 Programmatic Strategies and Goals

During its first year, the TFA was committed to deliver a technology program that was

- Applicable - addressed users' needs and was implemented within budget, schedule, and regulatory constraints
- Integrated - leveraged relevant activities across EM-30, EM-40, EM-50, and across and beyond the DOE complex

- Acceptable - had broad involvement of key stakeholders and incorporated expertise from outside the laboratory system (e.g., from industry and universities)

- Accountable - performed within budget and on schedule and produced a clear benefit.

At the same time, the technologies provided by this program were to

- Reduce the technical risks that jeopardized baseline tank remediation performance requirements

- Reduce the programmatic risks that 1) jeopardize the sites' ability to comply with regulatory or stakeholder drivers that were not part of the baseline plans or 2) limit the sites' ability to change their baselines in response to budget cuts

- Reduce environmental, safety, and health risks involving environmental, worker, or public safety issues associated with managing or remediating tanks

- Significantly reduce the overall cost of tank remediation.

Those programmatic strategies and goals were adopted as part of the new approach to doing business established by EM in FY95. Several programmatic strategies have evolved and improved since the publication of the previous MYPP. These include performer selection, alternative site technology baseline management strategies, and TFA linkages with users, other stakeholders, and other focus areas. These strategies are summarized in Sections 2 and 4.

The TFA has made great progress toward fulfilling its goals. The interest and participation by the users at the four sites made possible a full discussion of key issues, the identification of cross-site technology integration opportunities, and the collection of a wealth of user input and guidance. The TFA appreciates the invaluable contributions of Site Representatives, stakeholders, and TFA team members in industry, universities, and throughout the national laboratory system. The TFA believes these goals, which follow the 2006 Plan goals, are applicable until the tank waste remediation task is complete. With continued participation of present partners and new partners expected in the future, the program will provide even greater cost and risk reduction benefits. This MYPP highlights progress during the past year and updates the plans for the next 3 years of the program.

1.4 Organization of Multiyear Program Plan

The MYPP consists of the following sections. Section 1 provides an introduction to the tank waste problem and the TFA. Section 2 provides an overview of the processes used to develop and implement the baseline recommendation: site needs assessment, TFA program definition, scope selection, and team development. Section 3 introduces technical strategies that describe a framework within which the TFA has recommended its focus for the next

3 years. It includes a TFA overview and describes the baseline recommendation. The baseline recommendation consists of activities within 29 problem elements. The problem elements were developed by the TFA Technical Team based on a process and systems-oriented view of tank waste remediation; the structure of the problem elements is similar to the work breakdown structures used by the sites. The structure facilitates program integration into the sites' baselines. The problem elements address broad-impact multisite needs, describe the technical problem underlying each need, and maps a path to resolve the technology development components. Each problem element also contains FY98-FY00 budget and scope projections. Detailed schedules and performance indicators will be presented in technical task plans supporting the TFA in FY98; these documents are separate from the MYPP but are a direct result of the multiyear planning described in this MYPP. Section 4 describes the program objectives and implementation. Section 5 lists the references used in writing this report.

Several appendices are attached. Appendix A describes DOE's baseline approach to remediating each site's tank waste as well as the site costs and risks associated with the remediation baselines. Appendix B consists of a summary of the current baseline technical and programmatic assumptions and more detailed descriptions of the recommended problem elements. Each description includes a problem statement, general work scope for FY98-FY00, benefits of the technology, and funding information. Appendix C summarizes the TFA's expected support from other DOE sources, including crosscutting programs, the Environmental Management Science Program (EMSP), Industry and International Programs, and Technology Deployment Initiative (TDI). Appendix D provides a TFA "who's who," and Appendix E contains a list of acronyms and a glossary of terms used in this document.

Larger tables for each section of this MYPP are provided at the end of each section. Other figures and tables are placed after they are called out in the text.

Section 2 – Program Development Process

In FY97, the TFA instituted a newly revised process to support development of the FY98 and FY99 program. It emphasized closer and continuous partnership with users at the four tank waste sites in understanding site needs, development of technical responses to them, and development of a better integrated program to implement approved responses. The new process serves to foster the following:

- Continuous assessment of needs
- Increased dialog and communication
- Broader technical input in developing the TFA technical program
- Improved expression of needs
- Better understanding of the prioritization process
- Increased duration for developing technical responses.

2.1 The FY97 Process

The following is an explanation of the six-step process used to develop the TFA program as depicted in Figure 2.1. The actual or anticipated dates for each step are shown in parentheses in the following text, with the overall schedule shown in Figure 2.2.

- **Site Needs Identification & Documentation** (October 1996-December 1996) - Each site used its own process. Generally, sites relied on or involved their STCGs to identify and document tank-related needs.

- **Site Communication of Priority Needs** (December 1996-January 1997) - The TFA Site Representatives agreed to describe and submit needs using a new STCG-developed template. Proper completion of the template greatly improved the quality of the input required for TFA's comprehensive needs analysis. In addition, fully completed templates permitted the TFA to develop higher quality technical responses sooner than in the past.

- **Technical Response Development** (January 1997-March 1997) - Technical response development began with the analysis and categorization of each need. Upon receipt by TFA, each need was screened, reviewed for completeness, tentatively placed within the TFA problem element structure, and assigned to a TFA Technology Integration Manager according to function. The functions are safety, characterization, pretreatment, immobilization, retrieval, and closure. Incomplete needs templates were referred back to the submitting site for completion before a technical response was developed.

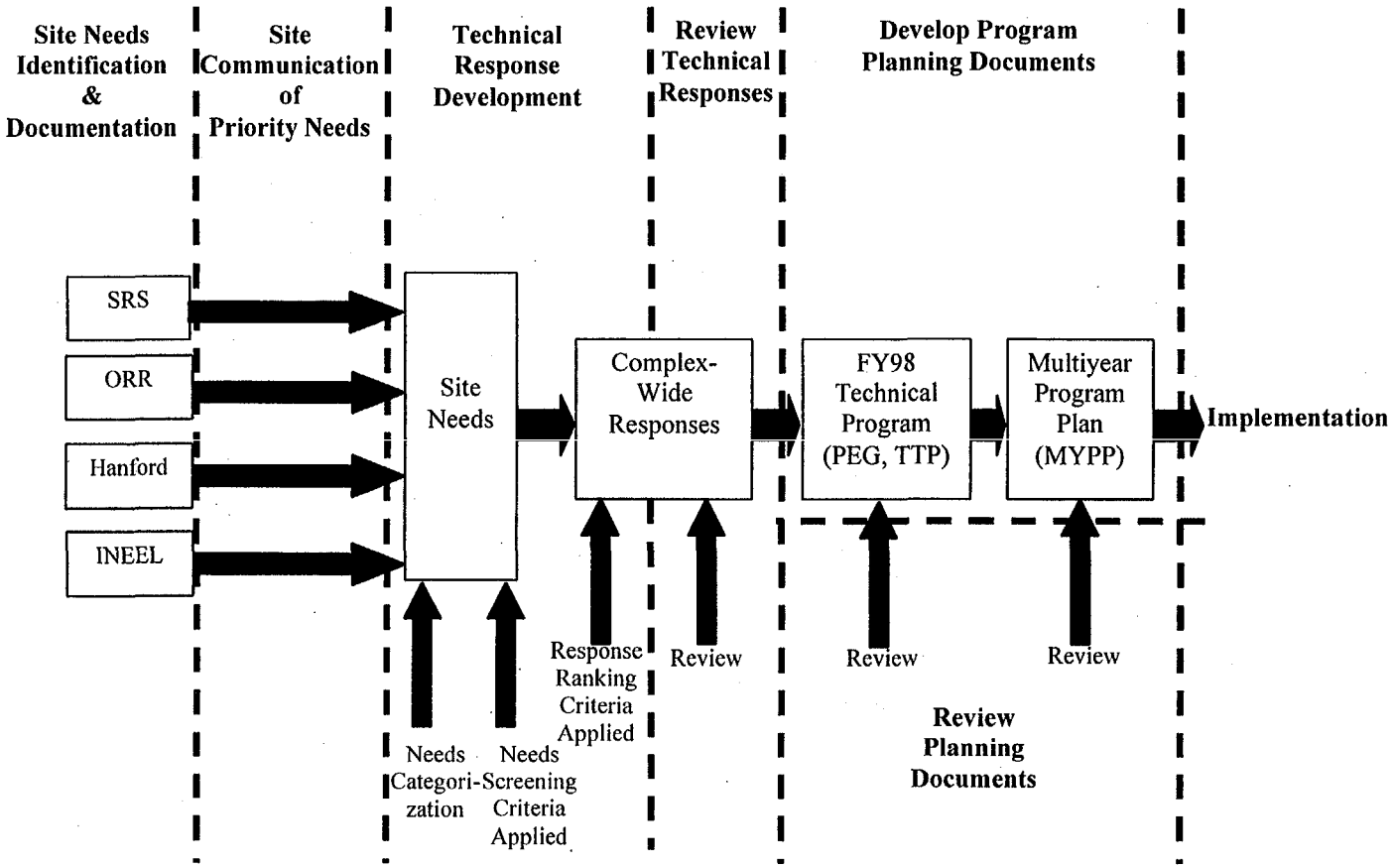


Figure 2.1. Tanks Focus Area Program Development Process

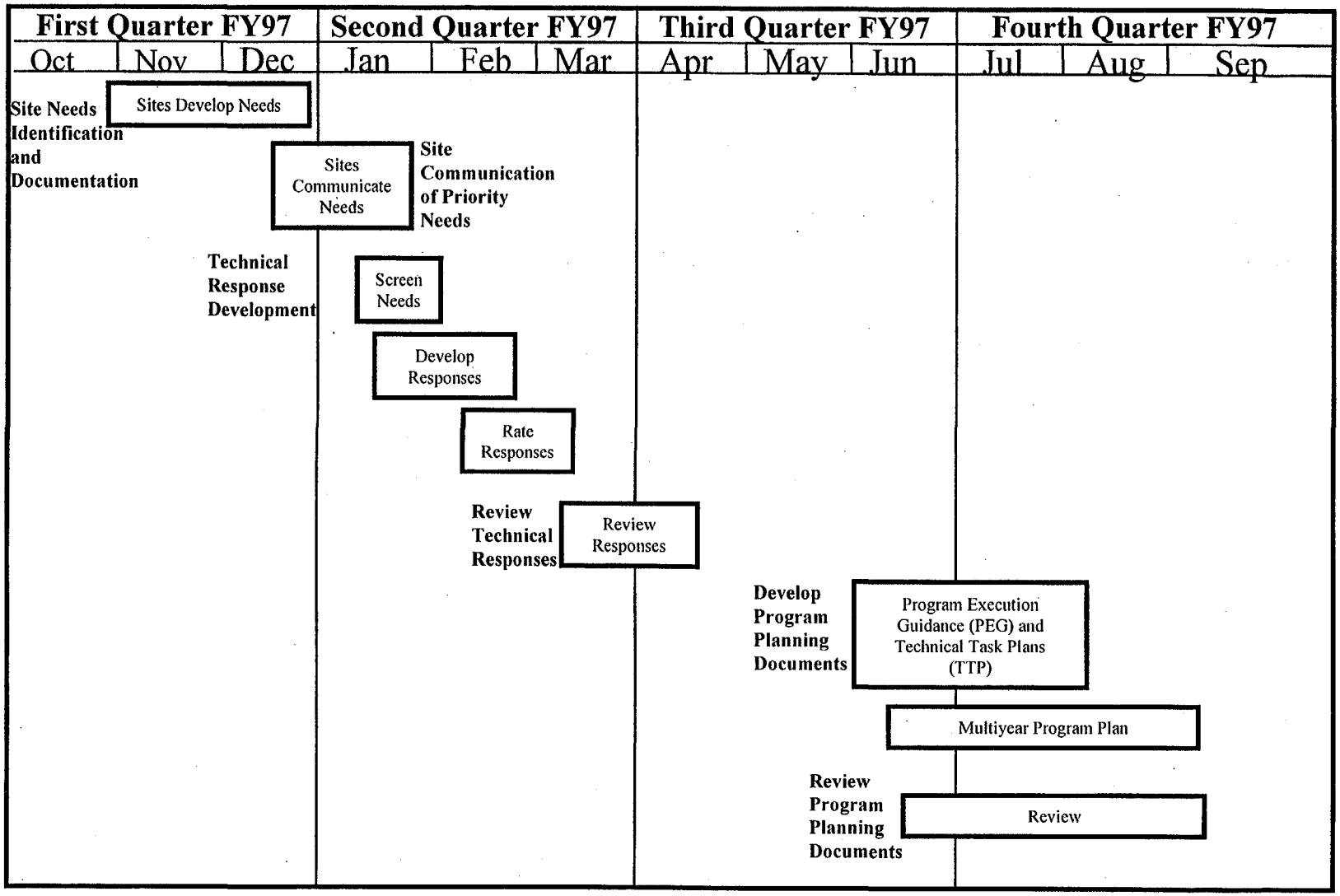


Figure 2.2. Tanks Focus Area Program Development Process Schedule

The TFA studied each need and developed potential integrated technical responses. As necessary, the need technical point of contact was consulted if further clarification was required. During the initial stages of technical response development, each need was subjected to an initial needs screening. The purpose of this screening was to assess whether the

- need and possible technical response was within the TFA mission area
- need and possible technical response possessed a technology development component
  - development, first-time hot demonstration or deployment, re-engineering, etc., was required
  - technology was available and no technology development was required
- response was technically feasible within the required schedule.

From mid- to late January 1997, the TFA prepared an initial draft response for each need. The composite set of technical responses were rated against criteria intended to rank them for further program development activities. Each technical response was rated against the criteria using a scale of "High, Medium, Low." Typically, the TFA assigned 100 points for a "High" score, 50 points for a "Medium," and 1 point for a "Low" score. The criteria included the following:

a) **Broad-Based Benefit (multisite).** This criterion remained unchanged from last year, and rated whether technical responses could be deployed at multiple sites or with multiple tanks at a single site. The ratings were defined as follows:

i) High

- technical response satisfied a high-priority need at one site and similar or related medium-priority needs at two or more sites
- technical response satisfied high-priority needs at two or more sites.

ii) Medium

- technical response satisfied a high-priority need at one site and similar or related medium-priority needs at one other site
- technical response satisfied medium-priority needs at two or more sites.

iii) Low

- technical response satisfied a medium-priority need at one site and low-priority needs at other sites

- technical response satisfied low-priority needs at one or more sites.

b) **Cost Reduction (Mortgage Reduction) Potential.** This assessment of mortgage reduction used criteria designed into the Risk Data Sheet process employed last year. The site needs input have contained cost savings information pertinent to the submitting site, and the TFA's task was to estimate complex-wide cost savings potential.

i) High

- without the technical response, there was a very high or high likelihood that DOE could not achieve moderate to significant savings in infrastructure, management systems or program implementation, accident-related capital, or operational costs

- technical response would avoid probable costly delays in ongoing remediation; magnitude of cost savings provided in needs statement(s)

ii) Medium

- without the technical response, there was a medium likelihood that DOE could not achieve moderate to significant savings in infrastructure, management systems or program implementation, accident-related capital, or operational costs

- technical response would avoid possible costly delays in ongoing remediation; magnitude of cost savings was described, not quantified, in needs statement(s)

iii) Low

- without the technical response, there was a low likelihood that DOE could achieve moderate savings in infrastructure, management systems or program implementation, accident-related capital, or operational costs

- technical response might reduce the risks of less costly or less central remediation functions; magnitude of cost savings was not provided in needs statement(s).

c) **Support to the TFA Strategic Goals.** The sites prioritized their needs for the benefit of the particular site, and the TFA's task was to assess the technical responses' complex-wide impact. The TFA's strategic goals provided a framework for this complex-wide assessment. The goals were

- demonstrate, deploy, and provide performance data for four tank waste retrieval systems to meet EM's FY00 requirements

- provide tank waste treatment technologies that can efficiently pretreat and immobilize 80% of HLW

- demonstrate compact processing units (CPUs) for HLW treatment and immobilization as an effective alternative to large-scale functions

- provide subsystems necessary to support the closure of 16 radioactive waste storage tanks.

The TFA applied the following scale:

i) High - technical response to this need would achieve a goal

ii) Medium - technical response to this need supported a goal

iii) Low - technical response to this need did not achieve or support a goal.

d) **User Commitment to Deploy.** The TFA assessed the user's commitment based on interest expressed in the needs description and present or future co-funding. Other influencing factors included regulatory justification and consequences of not satisfying the need. All of these factors were included within the site needs template.

i) High - site(s) co-fund development and deployment; was in site baseline

ii) Medium - site(s) may co-fund development costs; costs committed to co-fund deployment were not guaranteed

iii) Low - no indication of site co-funding.

The criteria were applied to the initial draft technical responses in meetings held on February 4-6, 1997. The prioritization process was accomplished in a group consensus of Technology Integration Managers, monitored by RL, based on available information on the needs. During the remainder of February, the TFA finalized the draft technical responses. Part of this process was the application of an additional technical strategy and a quality control measure using the TAG. The final form of the technical responses consisted of a STCG-developed response template, supplemented by TFA-added information. It was documented in the TFA's Site Needs Assessment released in April 1997 (available on the TFA Technical Team homepage at http://www.pnl.gov/tfa). The TFA's intention was to provide technical responses that would

- respond to each need received

- contain an explanation of the draft priority of the response according to either
  - screening criteria
  - prioritization criteria
- describe multiyear intent
  - 4-year budget estimate (current +3)
  - basis of estimate (rationale)
- describe the intended scope (2 to 3 paragraphs)
- identify the relationship or benefit to other site needs.

The TFA Management Team (DOE) established task priorities during the TFA Midyear meeting on March 6, 1997. The Management Team analyzed input provided by the Technical Team and the USG in determining funding priorities that would best serve the needs of individual sites and the DOE complex as a whole. The priorities they established formed the foundation of the TFA program discussed within this MYPP. There have been only minor changes to the original priority listing, which the Management Team has authorized through a consensus of all Management Team members.

- **Review Technical Responses** (Mid-February to mid-April 1997) - The TFA worked to obtain site input and consensus on the technical responses. The TFA was prepared to best accommodate each site's situation to obtain consensus, whether by telephone coordination, site visits, or other means. Reviews were conducted by the Management Team (especially the DOE Site Representatives), USG, and TAG. The objective was to get early approval and consensus on the technical program from DOE and contractor users and the TFA technical advisors. During this process, the Management Team, with full Site Representative participation, established the mulityear program priorities with input from the Technical Team and USG.

- **Develop Program Planning Documents** (June to mid-September 1997) - Successful completion of the previous four steps significantly simplified the preparation of follow-on program development documents. These included development of the FY99 Internal Review Budget, FY98 Program Execution Guidance, and development of this MYPP. In the past, these program documents were based largely on technical responses to the needs without sufficient time for consensus among the sites. In this year's process, complete consensus was obtained throughout the entire program development process.

- **Review Planning Documents** (June to mid-September 1997) - With full site buy-in already accomplished, the only review requirement expected was to accommodate late program adjustments not previously coordinated. This year's MYPP will receive an additional review by the High-Level Waste Steering Committee.

2.2 Team Selection and Activity Planning

Once the scope of the technical elements and site technical activities has been defined and appropriately focused, the TFA will select the organization (and participating team members) accountable for managing each technical activity. The selection of accountable organizations for new starts and refocused activities will be based on the technical merit of the proposal, ability to meet the user's needs on time, team qualifications, institutional capabilities, collaborations (e.g., with industry, universities, and users), cost reduction potential, and how well the work is planned.

Implementation of the selection criteria will result in a program that uses the best technical expertise, has a high probability of success, and has appropriately involved industry and university partners. The organizations performing ongoing technical activities will be encouraged to revisit their team composition to ensure that they have the best teaming arrangement possible. The TFA Technical Team will facilitate the selection of accountable organizations, supported by the TFA Technical Review Group, and confirmed by the TFA Management Team.

Three strategy guideposts, or key drivers, characterize the TFA's performer selection and call for proposals logic. First, the TFA is committed to engage the "best and brightest" performers, whether they are from the public or private sector. Second, in keeping with EM's interest to gain and maintain a commitment to commercialization, the TFA prefers a bias toward private industry. Lastly, the selection of performers is subject to the practical constraints of opportunity and access to tank sites and radioactive tank waste samples.

The FY98 program execution guidance represents ongoing, continuing work, as well as new starts. Continuing work includes work conducted by a principal investigator who has been funded by any organization within the DOE where the work scope is being transferred to or leveraged by the TFA. Continuing work may be significantly rescoped to reflect updated site needs or address technical issues that surfaced in the previous year. For continuing work, the TFA's philosophy is to retain performing organizations, provided performance has been satisfactory. Satisfactory performance measures include successes in meeting scheduled milestones and staying within budget constraints. Work that has not been satisfactorily performed is considered for reissue to another performer. The selection process for the performer is the same as if the work was a new start.

For new starts, the first consideration is an assessment of possible constraints. Constraints include the need for special facilities or equipment, requirements for radioactive wastes, special access, transportation needs, or urgent time lines that preclude the possibility of a call to industry (~180 days to place). If no constraints exist, the TFA may elect to solicit industry or academia directly. However, should constraints exist, the TFA's default is to offer the work to the national laboratory system. For unconstrained tasks, the primary consideration is for industry participation.

The TFA's decision to offer certain work to national laboratories does not preclude eventual participation by industry and academia. The TFA encourages laboratories to establish outside partnerships and teaming arrangements. However, the TFA leaves this decision to the performing laboratory or principal investigator.

Activity planning is critical to both selection of accountable organizations and FY98 work authorization. Activity plans must be prepared in sufficient detail that the organization's technical and management capability can be adequately assessed. The activity plan should address the organization's approach for accomplishing the work, a schedule consistent with deliverable and milestone expectations, and a time-phased distribution of budget. Once the accountable organization is selected and the activity plan is approved, the plan becomes the basis to measure technical performance and accomplishments. The organizations performing ongoing technical activities will also be required to submit and receive approval of their activity plans.

2.3 Observations

Execution of this year's planning process, while much improved over previous years, provided lessons learned for the next planning cycle in FY98.

- Development of complex-wide needs. This year's emphasis on satisfaction of individual site needs detracted from the intention to also develop technical responses with increased multisite benefit. As a rule, most sites reduced the number and generalized the character of the needs compared to previous years. The TFA found it more difficult to relate potential technical solutions to this set of needs.

- Process for task prioritization - revised and applauded by team.

- Refinement of response criteria. A refinement of the technical response rating criteria is warranted before next year's technical program development cycle. Assessment of cost reduction requires firmer bases for measurement; review and modification, if necessary, of the TFA goals and their use in response rating should be accomplished; strengthening criteria to improve understanding of broad-based support and user commitment is necessary.

- Importance of site coordination. Compared to previous years, the FY97 development cycle accomplished more and grew wider and deeper program knowledge. This led to an improved and stronger consensus for technical program direction. Closer site coordination clearly benefited the TFA.

- Use of reviews during technical program development. The TFA emphasizes the use of reviews to focus technical program development to the right issues. The TFA's extensive employment of the Management Team, including EM-30 Site

Representatives, USG, and TAG as critical reviewers proved beneficial again this year. The TFA will continue to use these valuable resources, and others as appropriate, to ensure program applicability, efficiency, and economy.

Section 3 – TFA Technical Program

This section describes the assumptions and recommendations for a nationwide technology program that addresses high-priority site needs associated with DOE's baseline approach for remediating and closing tanks. It provides an overview of the program, including technical accomplishments, impacts, strategies, and tables that summarize the problem elements of the TFA program (with their problems, solution paths, and deliverables) and the recommended program budget.

3.1 TFA Technical Program Overview

In FY95, the TFA developed the organizational and technical basis for a nationally integrated technology program. During FY96, the TFA more fully developed the understanding of DOE complex-wide tanks remediation issues, for the team members, sites, users, and stakeholders. Two points characterized the TFA's technical program development and execution emphasis in FY97. The first entailed much closer relationships with the DOE tank sites and the users at those sites. This started with a better understanding of site needs and development of technical responses as described in the *FY97 TFA Site Needs Assessment*, published earlier this year (TFA 1997). The proposed technical responses underwent review by the entire TFA team, resulting in a consensus-based FY99 Internal Review Budget submission and construction of the final FY98 program.

The second characteristic of this year's program development and execution was an improvement in and expansion of leveraging and integrating other funding sources to deliver needed technologies more efficiently and economically. The TFA relied upon site co-funding as an indicator of site support for technical solutions. The TFA views user commitment as an essential binding element in partnerships to create and maintain successful user-producer-developer relationships. It is critical that the TFA teams and leverages with user programs to conduct demonstrations and deployments. Additionally, the TFA sought to increase leveraging opportunities elsewhere. These include working with other focus areas, crosscutting programs, Industry, International, University, and EM Science programs. Successful leveraging and integration remains challenging, and the TFA will continue to emphasize these interactions. Constantly changing budget priorities and changing site needs demand constant and significant management and technical attention. With the weight of the entire TFA team behind efforts to improve leveraging and integration, the current program development cycle should yield an even more responsive program for all EM tank investments.

With the cooperation of the various STCGs, this year's TFA site needs response development process included very close cooperation with the sites. The sites used standardized needs submission templates, and the TFA's technical responses to them used a similar standardized format. The TFA applauds the STCGs in adopting this process, as it enabled a more

thorough, balanced understanding of the needs and technical response development. With this, TFA program development achieved consensus far easier than in previous years. The TFA continues to follow priorities established by the entire TFA team in the pursuit of the FY98-FY00 program.

The TFA uses a problem element structure to summarize technical program direction. This structure provides a compact, understandable, and process- and systems-oriented program foundation useful to those not connected with day-to-day program details. The site needs assessment (see Section 2) resulted in technical responses that were placed within the problem element structure, and together defined the TFA's objective to meet the fundamental DOE remediation objectives of reducing technical, programmatic, or environmental, safety, and health risks and reducing the overall cost of remediation.

Essential to carrying site needs through to program development was the creation of problem elements. By describing the full range of tank waste remediation subjects, the problem elements support a program that is responsive to important tank remediation needs, either because of the needs' urgency and scope to a single site or for multisite benefit. The TFA assumes that EM-30 and EM-40 programs will continue to respond to high-priority site-specific problems. Therefore, the TFA must remain cognizant of tank technology needs and activities across the complex and continue to provide data relevant to complex-wide processing requirements and conditions so that technical solutions applicable at one site will benefit others. Table 3.1 lists the problem elements of the TFA.

3.2 FY95-FY97 TFA Technical Accomplishments

This Multiyear Program Plan establishes a technical framework for the next three years. However, the program's future direction is, in part, a product of past successes and lessons learned from many organizations and people throughout the complex. TFA-sponsored technical accomplishments have improved operations, solved problems, and answered questions necessary to address future operational issues at all four tank sites. The following summarizes the TFA's accomplishments from FY95-FY97.

- Hanford Site - The TFA addressed supernate treatment for Phase I privatization, waste characterization to support safe storage, and waste retrieval and tank closure to support Phase II privatization. In doing so, the TFA

  - Developed a Raman probe package installed in the Hanford 35-ton cone penetrometer for in-tank species detection
  - Demonstrated electrical resistance tomography to detect plumes and leaks in the vadose zone
  - Demonstrated cross-flow filtration in a hot cell unit on actual Hanford waste
  - Developed and deployed rapid analysis tools to support characterization (Laser Ablation/Mass Spectrometer, Near Infrared Spectrometer)

Table 3.1. Problem Element Structure[a]

WBS#	Problem Element
1.0	Remediate Tanks
1.1	Store Waste
1.1.1	Extend Tank Life
1.1.1.1	**Monitor Tank Integrity**
1.1.1.2	Avoid Tank Corrosion
1.1.1.3	Remediate Loss of Tank Integrity
1.1.2	**Ventilate Tanks**
1.1.3	Characterize Waste
1.1.3.1	**Characterize Waste In Situ**
1.1.3.2	Sample Waste
1.1.3.3	**Analyze Waste**
1.1.4	Reduce Waste Volume
1.1.4.1	**Reduce Source Streams**
1.1.4.2	**Reduce Recycle Streams**
1.2	Process Waste
1.2.1	Retrieve Waste
1.2.1.1	Deploy Equipment
1.2.1.2	**Mobilize Bulk and Heel Wastes**
1.2.1.3	**Mix Waste**
1.2.1.4	**Transfer Waste**
1.2.1.5	**Detect and Mitigate Leaks**
1.2.1.6	**Monitor & Control Retrieval Process**
1.2.1.7	**Integrate Retrieval and Pretreatment Technology Systems**
1.2.1.8	Mobilize Heel
1.2.2	Pretreat Waste
1.2.2.1	**Calcine Waste**
1.2.2.2	**Dissolve Waste**
1.2.2.3	**Prepare Retrieved Waste for Transfer and Pretreatment**
1.2.2.4	**Clarify Liquid Stream**
1.2.2.5	**Remove Radionuclides**
1.2.2.6	Integrate Pretreatment and LLW Immobilization Technology Systems
1.2.2.7	**Process Sludge**
1.2.2.8	**Prepare Pretreated Waste for Immobilization**
1.2.2.9	Monitor & Control Pretreatment Process
1.2.3	Immobilize Waste
1.2.3.1	Process LLW
1.2.3.1.1	Monitor & Control LLW Immobilization Process
1.2.3.1.2	Prepare LLW Feed
1.2.3.1.3	**Immobilize LLW Stream**
1.2.3.1.4	Treat LLW Offgas
1.2.3.1.5	Dispose of LLW
1.2.3.2	Process HLW
1.2.3.2.1	**Monitor & Control HLW Immobilization Process**
1.2.3.2.2	Prepare Secondary Waste from Pretreatment
1.2.3.2.3	**Prepare Sludge Feed**
1.2.3.2.4	**Immobilize HLW Stream**
1.2.3.2.5	Treat HLW Offgas
1.3	Store Waste Forms and Close Tanks
1.3.1	**Close Tanks**
1.3.1.1	Monitor Tank
1.3.1.2	**Characterize Heels**
1.3.1.3	**Define Closure Criteria**
1.3.1.4	Treat Supernate in Place
1.3.1.5	Treat Heel in Place
1.3.1.6	Detect Leaks
1.3.1.7	**Stabilize Tank for Closure**
1.3.1.8	Monitor Site
1.3.2	Dispose of LLW
1.3.2.1	**Monitor Waste for Acceptance**
1.3.2.2	**Determine Performance of Waste Form**
1.3.2.3	Provide Disposal System
1.3.3	Store and Dispose HLW
1.3.3.1	Provide Interim Storage HLW
1.3.3.2	Provide Shipping Facilities

(a) Bold problem elements are those in which TFA is making investments in FY98 and beyond.

- Developed and deployed an in-tank characterization and inspection system (Light-Duty Utility Arm (LDUA) with camera system)
- Demonstrated an in-tank waste volume measurement system
- Performed supernate treatment tests (remove cesium and technetium using sorbents)
- Developed sludge processing (baseline)
- Demonstrated two arm- and two vehicle-based heel retrieval systems
- Developed and demonstrated a light weight scarifier used on one of the arm-based retrieval systems.

- INEEL - The TFA obtained data required for Title 1 Design per the Batt Agreement through process development for treatment and immobilization. In doing so, the TFA collected and incorporated flowsheet data into user plans (removed TRU and strontium using solvent extraction, and separated solids and liquid using cross-flow filtration.

- Oak Ridge Reservation - The TFA addressed gunite characterization and waste retrieval to meet Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements, and addressed the processing of Melton Valley Storage Tanks (MVST) waste to increase waste storage capacity. In doing so, the TFA

  - Provided technologies for gunite tank remediation (Modified Light-Duty Utility Arm [MLDUA] and Houdini, Confined Sluicing End-Effector (CSEE), and Characterization End-Effectors)
  - Increased waste storage capacity by processing two 25,000 gallon batches of Melton Valley Storage Tank supernate (removed cesium using crystalline silicotitanate in a CPU, and reduced waste volume using the Out-of-Tank Evaporator in a CPU).

- Savannah River Site - The TFA addressed the closure of SRS tanks and HLW process improvements. In doing so, the TFA

  - Used grout methods to close Tank 20
  - Demonstrated caustic recycle for reducing volume of waste to saltstone
  - Developed data to optimize waste loading at Defense Waste Processing Facility (DWPF).

These accomplishments were possible through effective partnerships with users, producers, and developers throughout the complex. The TFA desires even greater success in performance of the FY98-FY00 program. Anticipated technical program impacts for this period are described next.

3.3 FY98-FY00 TFA Technical Program Impacts

DOE-EM has set overall performance metrics for HLW for FY98-FY00. EM-30 identifies the number of canisters produced and the number of tanks closed. EM-40 identifies the number of tanks cleaned and ready for closure. The TFA supports these measures by

providing technical solutions to the key problems associated with meeting the DOE-EM metrics. The technical solutions are described by the functional areas of waste mobilization and retrieval, tank closure, waste pretreatment, and waste immobilization. Safety, characterization, and monitoring requirements are integrated into the technical solutions in each functional area. The problem associated with each functional area along with the technical solutions and key milestones marking significant progress toward problem resolution are provided.

3.3.1 Waste Mobilization and Retrieval Impacts

To meet processing, cleaning, and closure requirements, tank waste must be removed from the tanks. Removal requires that saltcake be dissolved and pumped to process tanks, that sludge can be mobilized and slurried to process tanks, and that mixtures of saltcake, sludge, and other materials including zeolites, and debris can be removed for further processing. Moreover, the removal processes must be monitored to ensure wastes meet process feed specifications and must be efficient to avoid adding excess water to the system, which adds to processing cost and can be a leakage concern in tanks of questionable integrity. Finally, waste must be retrieved in a manner that controls conditions that could lead to unwanted plugging of transfer pipes. In FY98-00, the TFA will provide technical solutions to solve the specific problems at Hanford, ORR, and SRS.

- Hanford - Hanford requires technologies to ensure tank integrity and to characterize, mobilize, and retrieve single-shell tank (SST) wastes to prepare for Phase II Privatization. In FY98, the TFA will support a demonstration of a second-generation tank corrosion. In FY99, the TFA will support demonstration of a third-generation corrosion probe and cold demonstration of an industry retrieval system for SST heel retrieval. In FY00, the TFA will support the planned deployment of the final design tank corrosion probe, hot deployment of a mechanically-based heel retrieval system in tank C-106, and cold demonstration of enhanced sluicing for heel retrieval.

- Savannah River Site - SRS requires technologies for dissolution and retrieval of saltcake from tanks and annuli, as well as sludge heel retrieval to meet canister production and tank closure goals. During FY98, the TFA will support the deployment and demonstration of saltcake retrieval with spray equipment in the annulus of Tank 16, and assembly and testing of sludge heel retrieval equipment for Type IV tanks. In FY99, the TFA supports saltcake retrieval with density gradient deployment in-tank for hot demonstration, and deployment in-tank for hot demonstration of sludge heel retrieval in Type I/II tanks.

- Oak Ridge Reservation - ORR requires technology to mobilize and retrieve waste from active Bethel Valley Evaporator Service Tanks (BVEST) tanks and inactive Old Hydrofractuyre (OHF) tanks. These wastes will be consolidated at the MVSTs in preparation for further processing by a private vendor. Transfer lines are small in diameter and measures to avoid plugging are required. To support mobilization of waste

for transfer, the TFA will deploy the pulse jet mixer for BVEST, the borehole miner in the OHF, and complete Pulsair® mixer and in-line solids monitor feature testing in FY98.

3.3.2 Tank Closure Impacts

To meet tank cleaning and closure goals set by DOE-EM, the sites require technologies that obtain data needed to negotiate closure criteria with local regulators. Sites also require cleaning methods that do not introduce excess water or chemicals that have undesirable effects, such as foaming, on downstream processes. Finally, sites require stabilization technologies to encapsulate or immobilize residual waste as well as provide structural stability and isolation of the tank. In FY98-00, the TFA will provide technical solutions to solve the specific problems at Hanford, ORR, and INEEL.

- Hanford - Hanford requires technologies that can characterize the vadose zone in the tank farms. Data from the vadose zone characterization is taken along with tank waste characterization and retrieval performance data to help the site negotiate closure criteria for SSTs. In FY98, the TFA supports two types of characterization tasks: deployment of sensors on the Hanford cone penetrometer to characterize the vadose zone in the AX Tank Farm, and the LDUA with sampling end effectors to determine waste volume and other key characteristics.

- Oak Ridge Reservation - ORR requires technologies to immobilize the residual waste in-tank. Additionally, the site requires technology to isolate these tanks from the environment to avoid in-leakage and ensure long-term stability. In FY98, the TFA supports immobilization of residual waste by establishing grout specification and emplacement requirements and complete fabrication of a GAAT plugging system. In FY99, the TFA will support the deployment a system to plug transfer lines in-tank, and develop an in-tank sludge mapping system. In FY00, the TFA will support the deployment of the grout injection system in-tank.

- Idaho National Engineering and Environmental Laboratory - The TFA will assist INEEL in obtaining data required for EIS and Title I design per the Batt Agreement. INEEL requires data and technologies to establish a baseline for processing wastes, ceasing use of tanks, and closing tanks. A key step in this process is the sampling of the heels to set the basis for process development and provide a basis for retrieval and closure decisions. INEEL requires technology for this sampling step. In FY98, the TFA supports the deployment of the LDUA with end effectors which retrieve HLW tank heel samples.

3.3.3 Waste Pretreatment Impacts

To meet the DOE-EM goal of producing waste canisters, technology is required to pretreat the waste to meet immobilization feed requirements. Additionally, significant cost reductions for disposing of immobilized waste can be achieved by improving the

pretreatment processes so that fewer HLW canisters and less volume of low-level waste (LLW) waste form results. In FY98-00, the TFA will provide technical solutions to solve the specific problems at Hanford, ORR, INEEL, and SRS.

- Hanford Privatization Phase I - Hanford requires technologies to ensure that the feed stream provided to the vendors in Phase I meets the feed stream specifications. Sampling and analysis techniques for the feed stream verification are needed. Also, the conditions under which the feed streams must be retrieved, blended, and stored in a manner that allows them to meet specification such as solids concentration must be developed. In FY98, the TFA supports feed specification development with the preparation of a test model of saltcake dissolution to ensure that conditions under which reprecipitation occurs are identified so that these conditions can be planned for or avoided when delivering waste feed to vendors. In FY00, the TFA will support hot deployment of a variable depth sampling system that will ensure feed specifications to vendors are met.

- Hanford Privatization Phase II - Hanford requires technologies to determine sludge processing limitations and enhancements to ensure that Phase II is successful. Data is needed to understand and evaluate the technical risks of privatization as a contracting approach. In FY98, the TFA provides support by issuing reports on chromium leaching, leachate chemistry, and enhanced sludge washing.

- Idaho National Engineering and Environmental Laboratory - The TFA will assist INEEL in obtaining data required for Environmental Impact Statement (EIS) and Title I design per the Batt Agreement. INEEL requires data and technologies to establish a baseline for processing acidic wastes from which TRU, Sr, and Cs must be removed. The technologies must be applicable to both tank waste and dissolved calcine waste. A solvent extraction process train is likely; hence, solids removal prior to the solvent extraction step is also needed. Each unit operation must be tested individually and then demonstrated as an integrated process to obtain the performance and operational data required. TRUEX and SREX have previously been tested for TRU and Sr removal, respectively; cross-flow filtration for tank waste is being been demonstrated as an individual unit operation. INEEL also requires technologies for calcination of sodium-bearing wastes. The TFA will complete a report summarizing cesium removal test results and complete solid-liquid separations tests using actual dissolved waste in FY98. In FY99, the TFA will demonstrate an integrated pretreatment process. Completion of the calcining process testing is scheduled for FY00.

- Oak Ridge Reservation - The TFA provides support to ORR privatization to ensure that wastes meet feed stream specifications. ORR requires technologies to ensure solids are controlled. In FY98, the TFA will complete fabrication of a solid-liquid separation demonstration system, and in FY99 will demonstrate and transfer the system to the user.

- Savannah River Site - The SRS requires technologies that can enhance the baseline waste processing before and after immobilization in DWPF. Specific areas of interest are

reduction in the volume of waste immobilized in saltstone, less costly tank ventilation systems that can be used on tanks in the tank farms used as process tanks, and reduction of volume of water recycled from DWPF to the tank farms. In FY99, the TFA will demonstrate a CPU using an out-of-tank evaporator on the saltstone feed stream to reduce water volume. Also, the TFA will demonstrate a tank filter to improve tank ventilation. In FY00, the TFA will demonstrate a compact processing unit for the DWPF recycle stream which removes cesium, solids, and mercury.

3.3.4 Waste Immobilization Impacts

To meet canister production requirements, existing processes must be able to handle a broader envelope of waste streams than currently available. Moreover, significant reductions in cost can be achieved if fewer canisters can be produced per volume of waste processed. In FY98-00, the TFA will provide technical solutions to solve the specific problems at Hanford, ORR, INEEL, and SRS.

- Hanford - To support privatization Phases I and II, Hanford requires technologies to establish methods for waste acceptance testing that can be used as a basis for payment to the private vendors and ensure safe interim and long-term storage for HLW and LLW, respectively. In FY98, the TFA will support waste form product acceptance testing by completing round robin testing of non-radioactive glasses to validate the precision and accuracy the test method. In FY99, the TFA will deliver standards and methods for product acceptance. Also in FY99, the TFA will demonstrate immobilized low-activity waste (ILAW) form release tests. Hanford also needs data to support Phase II privatization. Waste loading optimization is required for waste types for which processing experience does not exist (e.g., high chromium waste). In FY98, the TFA will provide a waste loading technical report documenting T_L data. In FY99, data on liquidus testing on the Hanford matrix will be completed.

- Idaho National Engineering and Environmental Laboratory - INEEL requires data and technologies to establish a baseline for immobilizing acidic wastes. Denitration and integration of denitration with low-activity waste (LAW) immobilization are needed. Additionally, avoidance of corrosion problems in the melter is another key area of interest at INEEL. In FY98, the TFA will recommend a preferred thermal denitration process, and issue a report on materials of melter construction testing with sodium-bearing waste. In FY00, the TFA will support integrated testing of denitration and grouting.

- Oak Ridge Reservation - To support privatization, ORR requires the grout and glass formulation, performance, and cost comparison data to ensure proper evaluation of proposals and follow-on procurement oversight for immobilization of consolidated waste stream. In FY98, the TFA will complete a grout/vitrification lifecycle cost analysis comparison.

- Savannah River Site - To meet future canister production goals, SRS requires technologies to enhance DWPF processes to meet full production capability. Enhancements include waste loading optimization for the various waste types for which process experience does not yet exist. An improved pouring spout design for the third DWPF melter is also needed to enhance uninterrupted operations. Finally, SRS requires level and density monitors that have fewer operating problems and are less costly. FY98 support from the TFA includes providing a waste loading technical report documenting expanded DWPF T_L (liquidus temperature) data and determining potential increases in waste loading. In FY99, the TFA will demonstrate a new SRS melter pour spout design, and demonstrate a new level and density monitor in extended sludge washing and DWPF process tanks.

3.4 Strategy for Technology Development

In Table 3.1, problem elements shown in bold are those in which TFA is making investments in FY98 and beyond. Figure 3.1 illustrates the relationship between these problem elements and a generic tank remediation flowsheet. This figure depicts the systems approach taken by the TFA in developing a responsive program that provides integrated technology solutions to key user problems. The figure identifies the scope of work to be conducted by the TFA or in conjunction with the TFA. Hence, work conducted through the crosscut, industry, university, EMSP, other focus areas, and user programs as well as the TFA managed program is included (e.g., fully leveraged program). The TFA tasks are further identified by Technical Task Plan number for work to be conducted in FY98.

In Section 3.5, the technical strategy behind these investments for each of the problem elements is described. With a few notable exceptions, the general technology development strategy for the TFA is to acquire technology and prepare it for deployment in the operating environment. Preparation for deployment either involves 1) demonstration and data acquisition for the user to support decisions and flowsheet development or 2) deployment, testing, and transfer of new technology to the user for continued operation. Technology is acquired either from industry, crosscutting programs, university programs, international programs, other focus areas, or user programs. This latter situation arises when one site has successfully used a technology and with some adaptation a second site can also use the technology. The TFA supports the technology adaptation and transfer in these situations. The technologies that the TFA will acquire from industry and the other EM-50 programs are listed in the appropriate problem elements in Appendix B, summarized in Appendix C, and are identified briefly in each of the problem elements in this section. As the EM Science Program matures, the TFA will also look for technology and science developments that can be transferred. Currently funded EMSP projects are listed in Appendix C and by problem element in Appendix B.

The exceptions to this overall strategy of technology acquisition and preparation for deployment include retrieval process development, sludge processing, and HLW form and process development. Currently, EM-50 does not have crosscutting programs to address

these aspects of tank remediation, because the science and technology needed for these areas are specific to tanks. Therefore, the TFA does invest in these areas to bring less mature technology concepts forward for future deployment and technology transfer. These investments are included in the description of the problem elements in Section 3.5.

The problem elements were developed around key needs identified by one or more user sites for which either large cost reductions or a higher probability for successfully meeting site remediation goals could be achieved. The level and type of technology development investment within each of the problem elements reflects the general approach that TFA is taking. Namely, the TFA investments support current DOE strategy for remediating tanks. This strategy includes waste retrieval and processing to produce LLW forms for disposal onsite and HLW forms for disposal in a repository. This tank remediation strategy is the basis for Federal Facility Compliance Agreements (FFCA) at the four tank sites. However, the technology development investments are also applicable to alternative approaches and strategies that could be selected by DOE and site stakeholders in the future. The relationship between the technical development investments supporting the current strategy and potential alternative strategies for tank remediation is discussed in Section 4.5.

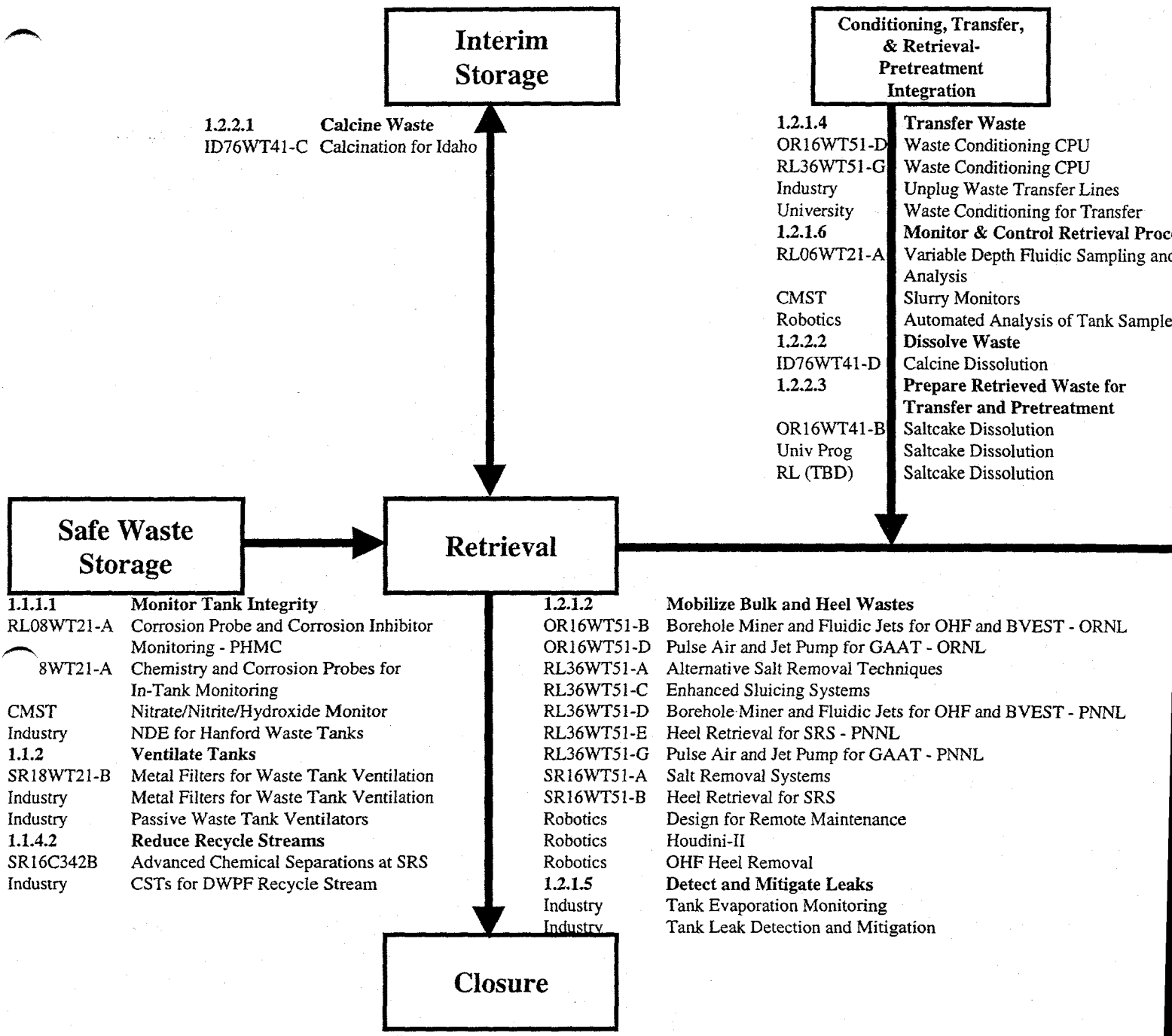
3.5 Technical Strategies by Problem Element

Problem Element 1.1.1 Extend Tank Life. Regardless of the remediation strategy eventually selected by each site, the tank life for most of the tanks will be exceeded by the time remediation is complete. Therefore, methods to slow the rate of corrosion that leads to loss of tank integrity could significantly reduce the risk of releases. Moreover, there are already tanks known or suspected to leak for which methods to determine the extent and location of leakage will provide a better basis for selecting monitoring, retrieval, and closure strategies. Therefore, the TFA is investing in this problem area.

The technical strategy for developing corrosion monitoring tools encompasses monitoring devices to determine corrosion rates, sampling and analysis of tank contents to ensure corrosion inhibitor concentrations are adequate, and in-tank inspection tools to identify and locate potential points for leakage before beginning retrieval operations. Measuring corrosion rates allows operators to forecast potential loss of tank integrity and to take preventive measures in time. The baseline technology is the use of coupons (i.e., small samples) to measure corrosion rates. This method requires recovery of the coupons from a tank to make corrosion rate measurements. Monitoring inhibitor concentrations allows operators to add chemical inhibitors at intervals to reduce the potential for corrosion.

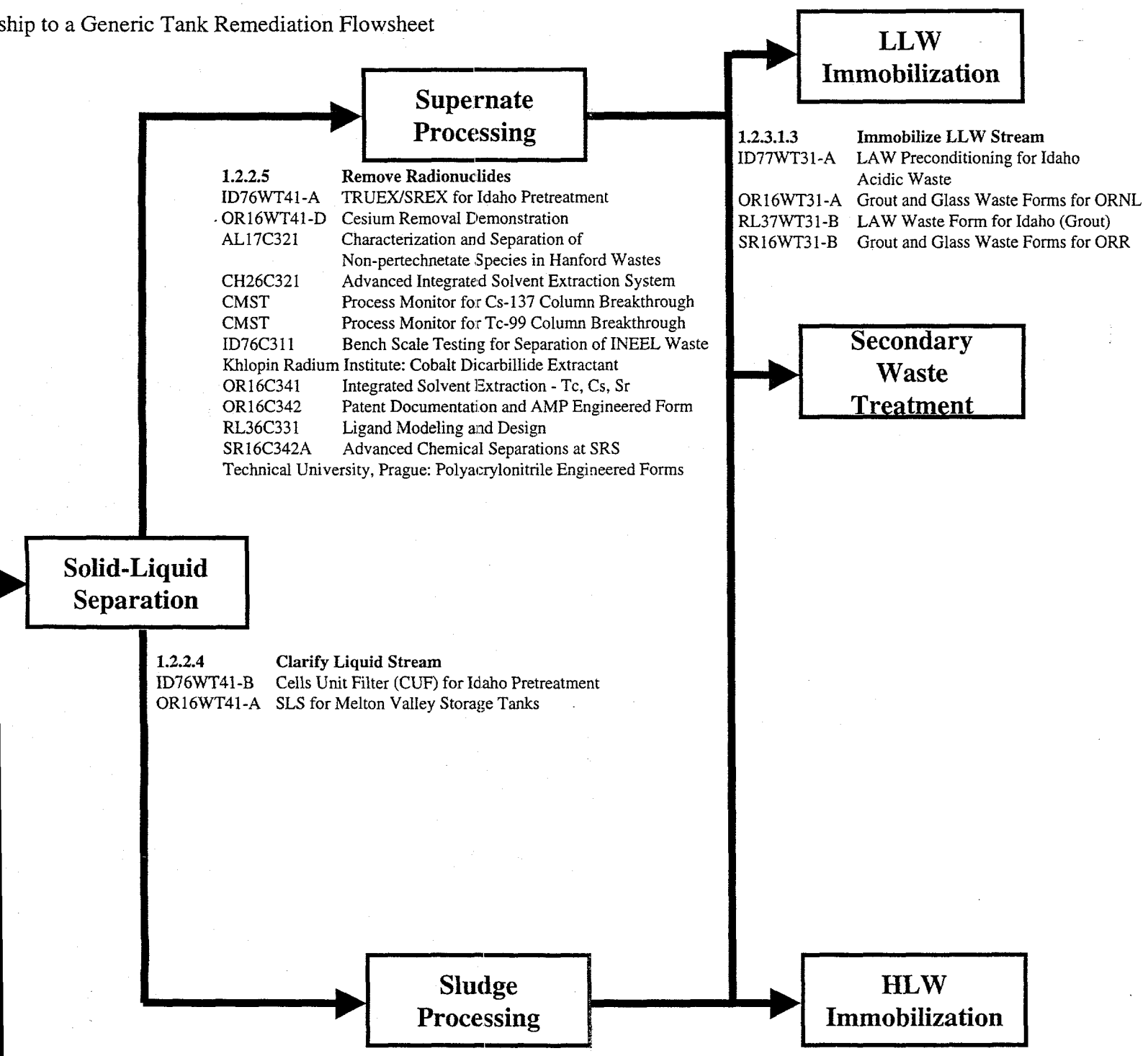
The baseline technology is sampling and laboratory analysis of tank liquids. In addition, understanding where leakage may occur allows operations to select appropriate retrieval tools and define mining strategies that reduce the potential for releases. The baseline technology is the use of cameras that are lowered through a riser with lights to visually inspect the tank. This method is limited to visual inspection. Specific technologies supported by the TFA to replace the baseline techniques include

Figure 3.1. Problem Elements Relati



AMP	ammonium molybdophosphate	LLW	low-l
BVEST	Bethel Valley Evaporator Storage Tanks	LDUA	Light
CMST	Characterization, Monitoring, and Sensors Technology	NDE	non-d
CST	crystalline silicotitanate	OHF	old hy
DWPF	Defense Waste Processing Facility (at SRS)	ORNL	Oak R
GAAT	gunite and associated tanks	ORR	Oak R
HAW	high-activity waste	OTE	Out-c
HLW	high-level waste	PHMC	Proje
HTI	Hanford Tanks Initiative	PNNL	Pacif
ICPP	Idaho Chemical Processing Plant	SLS	solid-
ILAW	immobilized low-activity waste	SREX	stront
INEEL	Idaho National Engineering and Environmental Laboratory	SRS	Savan
LAW	low-activity waste	TRUEX	transu

ship to a Generic Tank Remediation Flowsheet



aste
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National Laboratory
Reservation
Evaporator
ford Management Contractors
hwest National Laboratory
separation
traction
ver Site
xtraction

- Electrochemical noise corrosion monitor, which is deployed through a tank riser, for use at SRS and Hanford

- Raman-based nitrate, nitrite, and hydroxide ($NO^-_2/NO^-_3/OH^-$) in-tank sensor for corrosion inhibitor concentration monitoring at SRS

- Nondestructive examination end effector to be deployed by the LDUA for Hanford.

The technical strategy for developing methods to avoid corrosion includes both near- and longer-term approaches. In the near term, the strategy is to adapt commercial monitors to better control the current method for avoiding corrosion, the addition of inhibitor water. Inhibitor water is added to tank wastes to maintain the ratios of $NO^-_2/NO^-_3/OH^-$, which reduce corrosion rates. A monitor to detect the ratio of $NO^-_2/NO^-_3/OH^-$ in tank liquids can be used to control the volume of inhibitor water added to tanks during either waste storage or in-tank processing. This water increases the overall volume of HLW and LLW that must be processed and disposed. Thus, reducing inhibitor water volume reduces waste processing and disposal costs. The first deployment of this monitor, which is being acquired from industry, is scheduled for SRS tanks.

The longer-term strategy for avoiding corrosion in tanks includes development and assessment of corrosion monitoring methods that provide more direct and real-time measurement of the corrosion potential within a tank than do corrosion coupons. An electrochemical noise corrosion monitor will be tested at Hanford and SRS and evaluated for use in augmenting current monitoring methods to further reduce the costs of inhibitor monitoring and addition.

Problem Element 1.1.2 Ventilate Tanks. Waste tank ventilation is necessary to maintain safe operating conditions within the tank farm. Ventilation systems prevent exposure of workers to highly radioactive aerosols and particulate that are generated within the waste tanks during waste decay, mixing, and transfer. Baseline tank ventilation systems are typically comprised of condensers, demisters, heaters, high efficiency particulate air (HEPA) filters, and blowers. The primary costs associated with tank ventilation are energy demand for the active components (i.e., blowers, coolant pumps, heaters) and change-out of disposable HEPA filter elements. The TFA is investing in methods to reduce the costs and risks of tank ventilation by focusing on methods to augment or replace the baseline system and components. Specific technologies include

- Passive ventilation systems that reduce the capital equipment costs and need for blower systems at SRS

- Washable sintered metal filter systems to replace HEPA filters and reduce the costs and risks of frequent change-out of paper HEPA filters at SRS.

The near-term technical strategy is to select and demonstrate regenerable filter systems to replace HEPA filters within the existing active ventilation system. A commercial system will be procured for demonstration. In the longer term, several passive ventilation concepts will be explored and evaluated for use in replacement of the active ventilation systems on specific waste tanks at SRS. The passive system will rely on particulate and aerosol filtration and natural air flow in and out of the waste tanks rather than active blower operations. Although not all waste tanks may be amenable to passive ventilation due to safety limits on gaseous emissions, system designs will be evaluated that can maintain safe ventilation while reducing the energy and maintenance demands of active ventilation. Passive ventilation system designs will likely include the washable sintered metal filter concept and will benefit from ongoing design and testing of these systems.

Problem Element 1.1.3 Characterize Waste. Waste characterization is required for safe storage of waste and designing effective retrieval, pretreatment, and immobilization systems to process waste. Moreover, waste characterization, in conjunction with source term determination and performance assessments, help stakeholders define closure requirements for tanks, including the degree to which tank waste must be retrieved or treated in place. The TFA is investing in tools and methods to characterize waste in situ (Problem Element 1.1.3.1), and has previously invested in methods to sample waste (Problem Element 1.1.3.2) and analyze waste (Problem Element 1.1.3.3). Related activities to sample and characterize waste tank residuals for tank closure analysis are described in Problem Element 1.3.1 (Close Tanks).

Designing and deploying effective retrieval systems for tank wastes requires knowledge of the waste characteristics, such as the volumes and interface between supernate, sludge, and/or hard heel. The TFA has previously invested in the Topographical Mapping System (TMS) to "map" the surface of tank residuals once supernate has been removed. However, methods to map the sludge or heel level are still needed for tanks where the bulk supernate remains. A sludge mapping system will allow for design of the retrieval system and retrieval strategy before supernate removal. Baseline technology includes multi-level sampling to detect the sludge-supernate interface, at a single point within the tank. The TFA is specifically investing in a sludge mapping tool to measure the volume of sludge present in tanks before and after supernate retrieval at ORR.

The technical strategy is to build off of previous investments in the TMS to design an in-tank system for mapping the sludge surface or volume through a supernate layer without intrusive sampling and out-of-tank analysis. The system will be designed for use in ORR tanks such as the horizontal Melton Valley Storage Tanks, and may also be used in larger vertical tanks.

Problem Element 1.1.4 Reduce Waste Volumes. Tank farms are still receiving wastes even though major missions have ceased at most of the sites. Some of these wastes are or will be generated from decontamination and decommissioning (D&D) operations or from tank-to-tank transfer to solve various types of waste storage problems or from tank waste processing operations. An example of the latter situation is the recycle stream from the

DWPF at SRS. Removal of dilute concentrations of cesium, solids, and mercury from this stream would allow it to be processed through the site's water treatment plants for release through a National Pollutant Discharge Elimination System (NPDES) permitted outfall rather than being recycled to the tank farms for reprocessing through the plant. There is no baseline technology for treating this stream; it is simply added back to the tanks for storage and eventual reprocessing through the DWPF.

The technical strategy for addressing this problem is to assemble a treatment train of commercially available technologies to meet the waste acceptance criteria for the SRS's liquid effluent treatment plant. The TFA will evaluate the use of a compact processing unit concept to avoid large capital expenditures on new facilities. The TFA will also evaluate options for reducing mercury concentration in this stream, which would reduce the complexity of the treatment train.

Problem Element 1.2.1.2 Mobilize Bulk and Heel Waste. Bulk tank wastes are mobilized and/or mixed before removal from the tanks. These wastes are either supernate with sludge that must be resuspended before transfer, saltcake that must be dissolved and transferred, or residual sludges without supernate that must be put in a transportable form. The baseline technologies for bulk sludge waste retrieval at Hanford, SRS, and INEEL are mixer pumps coupled with transfer jets for supernate tanks and sluice/water brush for low supernate tanks. The mixer pumps, however, have relatively expensive life cycle costs and have two operating problems:

- Leaking seals introduce water into the tank waste, increasing overall waste volumes that must be processed

- Limited mixing radius of the mixer pumps increases the number of pumps required and hence, the capital, operating, and maintenance costs for these expensive pumps.

After the bulk waste has been removed, many tanks have a heel remaining. In some cases, the heel is soft but could not be removed due to slurry properties and depth limitations of the transfer jets. In other cases, the heels are very hard and difficult to break up and remove. The amount of material that can be left in a tank is directly related to the closure criteria. The baseline technology for heel removal is past-practice sluicing (water brush) in which water is sprayed at the surface of the heel at low pressures. Past-practice sluicing is also the baseline for saltcake at sites such as Hanford. This practice introduces large volumes of water that must be processed and for tanks that are known or suspected to leak, introduces a higher risk for release of tank waste during retrieval. At ORR, access limitations and tank configurations add complexity to the waste retrieval requirements. The process has a history of leaving sludge rubble that did not slurry and, therefore, could not be removed.

The technical strategy for bulk waste removal is directed toward improved methods for mobilizing soft sludges from mixer or transfer pumps to improve retrieval operations. The technical strategy for removal of saltcake is to move from past practice sluicing to reduced

water addition. The TFA investments are designed to support the users' current schedule for waste retrieval by leveraging with the operating programs to design, test, and deploy waste removal systems within the baseline schedule. Technologies to support bulk waste removal include

- Pulsed air systems developed by industry (i.e., Pulsair®) to suspend solids before transfer at ORR gunite and associated tanks (GAAT) (also part of water conditioning for transfer)
- Jet pump eductor improvements to extend operating life in support of GAAT retrieval at ORR
- Fluidic systems developed and used in the United Kingdom (through the International Program/AEA Technologies) (higher pressure sluicing system) to suspend and transfer solids at ORR's BVEST
- Borehole miner (from Waterjet Technologies Inc.) that will be used on the OHF tanks at ORR to mobilize sludges to support retrieval and transfer
- Salt dissolution and retrieval methods for removing salt from tanks and tank annulus at SRS
- Modified density gradient techniques coupled with low flow rate pumps for bulk saltcake dissolution and removal at SRS without mixer pumps
- Enhanced sluicing systems including enhanced nozzle and sweep designs for Hanford
- Russian pulse jets pump technology for slurry mobilization and transfer.

The technical strategy for heel retrieval involves adaptation and testing of commercial systems for heel retrieval at SRS and Hanford. In conjunction with the site baseline programs, TFA will develop functions and requirements for heel retrieval and procure and test systems for use in SRS Types I, II, and IV tanks, and in Hanford 106-C after bulk waste removal is complete. Successful demonstration and deployment of commercial heel retrieval systems will support strategy development and future site decisions on tank retrieval operations and the scope of privatization initiatives.

Problem Element 1.2.1.4 Transfer Waste. Waste transfer operations are required after retrieval to support more efficient waste storage, to support a retrieval operation, or staging of wastes for subsequent blending or pretreatment. Physical and chemical properties of the retrieved waste impact transferability. During transfers, pipeline plugging has occurred and can result in very costly delays and efforts to mitigate the plugging. The TFA investments in methods to minimize the potential for pipeline plugging during retrieval and transfer include activities to identify the key parameters that influence pipeline plugging and develop methods to condition waste prior to transfer. Development and testing of methods to mitigate

a plugged line is also being pursued to ensure that methods exist in the event prevention efforts are not completely effective.

The technical strategy involves:

- Evaluating the impacts of physical and chemical conditions on waste rheology and transfer for Hanford, ORR, and SRS waste types at Florida International University.

- Adapting and testing commercial systems for pipeline unplugging with side-by-side testing to evaluate the merits of a variety of systems. Functions and requirements, primarily from Hanford and SRS, will be used to select and test industry technologies acquired through a joint program between TFA and Industry Programs.

- Developing and deploying a waste conditioning CPU for transfer of GAAT waste to MVST.

Problem Element 1.2.1.5 Detect and Mitigate Leaks. There are approximately 80 radioactive waste storage tanks known or suspected to have leaked in the EM system to date. Before the remediation of tanks is completed across the complex, the life of most tanks will be exceeded. The TFA is investing in methods to avoid leaks and extend tank life as discussed under Problem Element 1.1.1. Nonetheless, for those tanks that have already leaked, technologies for tank waste removal with minimal environmental impact is needed.

The technical strategy for leak detection and mitigation is to provide 1) retrieval methods that avoid leakage by controlling and minimizing water, 2) leak detection devices that can provide rapid data output to guide retrieval operations, and 3) strategies to mitigate leaks once detected during retrieval. The baseline technology for leak detection measures the liquid level of the waste in the tanks during retrieval. Liquid level can be affected by the retrieval operation and is only accurate to tens of thousands (10,000s) of liters of leaked waste. Leak detection ultimately requires a real-time water mass balance that measures tank liquid level, water addition (e.g., sluicing water), and evaporation. Although liquid level and water addition measurements can be taken, current methods for evaporation monitoring are inaccurate and introduce too much uncertainty to the leak detection analysis. Moreover, the location of the leaks cannot be determined with the current baseline technology. The TFA has previously supported demonstration of Electrical Resistance Tomography that can be rapidly and inexpensively deployed with a cone penetrometer. Electrical Resistance Tomography was developed by the Characterization, Monitoring, and Sensors Technology Program and can detect leaks to hundreds of liters and identify the location of the leaks. Future TFA activities will emphasize industry support and technology to develop methods for leak detection and mitigation. The technical strategy will include assessment of the available leak detection and mitigation approaches followed by commercial contracts for development and testing of the appropriate systems to support baseline schedule for Hanford SST retrieval operations. Specifically, TFA, through Industry Programs, will explore commercial systems for

- Tank evaporation monitoring to reduce the uncertainty in the water mass balance allowing more accurate leak detection during retrieval

- Combined leak detection and mitigation that pin-point the location of the leak and provide strategy and methods to mitigate the loss of tank contents.

Problem Element 1.2.1.6 Monitor and Control Retrieval Process. During waste retrieval operations, slurries are transferred from the tanks through transfer lines to another storage tank or a process tank in preparation for pretreatment activities. Transfer line pluggage is a concern for operations. Moreover, particle size, weight percent solids, and chemistry changes occurring during retrieval impact the efficiency of the downstream pretreatment operations. Therefore, the physical and the chemical properties of the retrieved waste must meet certain operational requirements for retrieval and pretreatment operations to be successful. Physical properties include flow rate, viscosity, weight percent solids, and particle size distribution. Monitors that can provide these data are needed. In recent tests at Hanford, it was shown that currently available monitors could measure flow rate and viscosity (at least qualitatively); however, weight percent solid and particle size distribution could not be measured with currently available monitors. In addition to physical properties, chemical compositions are needed to ensure wastes meet pretreatment feed requirements. This is particularly important for feed to the private vendors, as is occurring under Hanford's Phase I privatization. The baseline technique is to sample slurried waste before transfer and conduct out-of-tank analysis.

The technical strategy for retrieval process monitoring is to improve sampling techniques, which enhance the current baseline technology. The technical strategy also includes providing alternative on-line and at-tank monitoring or analysis techniques to provide rapid, low-cost information to support waste transfer and feed to pretreatment. To improve sampling, simple methods that remove a homogenous and representative aliquot of slurry from a transfer line or feed tank must be tested. In addition, on-line slurry monitors and at-tank analysis methods that are able to provide real-time or near real-time, quantitative data on viscosity, weight percent solids, particle size distribution, and/or chemical composition must be developed. The following activities are supported by the TFA.

- Develop a multi-level fluidic sampling device (International Program/AEA Technologies) with at-tank analysis to support feed staging for Phase I privatization at Hanford.

- Prepare and downselect several types of on-line slurry monitors for testing and hot deployment at ORR (joint Characterization, Monitoring, and Sensors Technology Crosscutting Program and the TFA).

Problem Element 1.2.2.1 Calcine Waste. Calcining blended acidic wastes for interim storage has been the baseline technology for INEEL's tank waste stored at the Idaho Chemical Processing Plant. The remaining wastes, however, are higher in sodium and the

waste stream with which they have been blended in the past to reduce the sodium concentration is no longer available. Therefore, the current calcination process must be modified so that a product that meets performance requirements is produced. In addition, the waste processing baseline plan for INEEL includes a separations flowsheet option that is being pursued, and requires dissolution of calcines before radionuclide separation. Therefore, both technical advancements to support future calcination and developments of methods to dissolve existing calcine are required to meet the processing schedule for INEEL.

The technical strategy for calcining wastes is to develop and pilot test an advanced calcination flowsheet that will handle the sodium-bearing wastes while minimizing the chemical additives, controlling volatilization and fines generation, and producing a calcine that is safe and effective to transport, retrieve, dissolve, and is compatible with immobilization.

The technical strategy for dissolving the calcine wastes is to evaluate the chemistry and dissolution behavior of existing calcines and bench-test preferred dissolution schemes to support flowsheet design decisions.

Problem Element 1.2.2.3 Prepare Retrieved Waste for Transfer and Pretreatment. Physical and chemical properties of retrieved tank wastes can impact the efficiency of pretreatment. The physical properties include viscosity, weight percent solids, and particle size distribution. These properties can be affected by the chemical characteristics of the waste including speciation, pH, ionic strength, and the presence of a separable-phase organic layer. Various chemical combinations can lead to gelation, which will adversely impact fluid transfer (i.e., plug lines, and settle-decant rates). Ionic strength and pH can affect particle size and aggregation that can lead to the formation of colloidal material that can adversely affect settle-decant as well as downstream supernate and sludge processing. Separable-phase organic compounds may cause the partitioning of some constituents that can impact radionuclide removal efficiencies. A better understanding of the effects of these properties on pretreatment process efficiency is needed to ensure selection of appropriate performance requirements during retrieval and subsequent waste storage (e.g., washed sludge).

The technical strategy is to understand how the waste's chemical and physical conditions impact rheology and process chemistry. Particular emphasis will be placed on dilution of Hanford supernate and saltcake needed for Phase I privatization and wash and leach solutions Hanford sludges. Specifically, conditions that affect bulk transport properties, solids formation, and re-precipitation will be determined and translated to process requirements for retrieved waste. These requirements may in turn lead to the need for

- Dissolution conditions that avoid tank corrosion while resulting in waste streams that can be efficiently processed

- Recommendations on blending to improve downstream process efficiency

- Organic destruction requirements

- Recommended operating envelopes to minimize concentrate re-precipitation or leachate solids formation.

The TFA will support the following activities to better understand the operating requirements:

- Evaluate saltcake dissolution and concentrate re-precipitation phenomena in complex solutions using nonradioactive surrogates to upgrade thermodynamic models to support retrieval and storage operations at Hanford.

- Study dilution, leaching, and washing of Hanford sludges, in conjunction with Problem Element 1.2.2.7 to provide information on the solubility of components in complex solid-liquid systems and identify the operating envelope required to minimize solids formation problems during pretreatment.

As the EM Science Program (EMSP) matures, the TFA anticipates that scientific studies conducted through that program will also have relevance to these issues.

Problem Element 1.2.2.4 Clarify Liquid Streams. After retrieval, the wastes must be separated into supernate and sludge streams to reduce the volume of material going to the vitrification process. The baseline technology for this solid-liquid separation is settle-decant. The efficiency and rate of the settle-decant operations, however, does not appear adequate for many of the waste streams. For example, carryover of small particulates in the Hanford supernate may lead to LLW that exceeds the waste acceptance criteria for TRU and strontium, which tend to associate with these fine solids. Moreover, small particulates may clog ion- exchange columns used to remove cesium and technetium from supernate to meet LLW acceptance criteria. Therefore, methods to ensure clarification of liquids are needed to meet process requirements for pretreatment and LLW immobilization.

The technical strategy for clarification of liquids is three-fold: 1) complete collection of data on baseline at Hanford, 2) demonstrate techniques to enhance the baseline, and 3) provide process flexibility through compact processing units. The baseline process for Hanford is settle-decant without active filtration. Data for settle-decant operations are being developed on actual wastes at Hanford through the user program with some technical support from TFA. Enhancements to settle-decant include active filtration to remove fine particulates from the supernate. Cross-flow filtration, which is commercially available, has been selected as the filtration system for demonstration based on experience gained at SRS over the last decade. Active filtration is being or has been demonstrated on actual wastes at INEEL, ORR, and Hanford.

- **INEEL** - obtain performance data on cross-flow filtration to remove undissolved solids from acid and dissolved calcine waste and to evaluate regeneration with back pulse or non-acid wash (hot cell scale unit being used).

- **ORR** - obtain operational experience on a larger-scale system by preparing a hot demonstration on wastes for transfer to MVSTs.

Problem Element 1.2.2.5 Remove Radionuclides. Supernate processing is used by Hanford, INEEL, and SRS to reduce the levels of cesium, technetium, strontium, or TRU to meet LLW disposal requirements on-site. These requirements are established through performance assessment of the LLW disposal facility. For ORR, cesium removal is required to meet waste acceptance criteria established by the Nevada Test Site for LLW. The baseline technology at SRS is in-tank precipitation with tetraphenylborate. The baseline technology at INEEL is expected to be solvent extraction; however, these processes have not been fully demonstrated on actual INEEL wastes. The baseline technology for Hanford is still being determined, in part through privatization, but ion exchange is most typically used for flowsheet development. The baseline technology for ORR is ion exchange.

In general, the technical strategy for radionuclide removal is built around developing and demonstrating processes and process equipment using actual wastes for collection of performance and engineering data. The TFA is acquiring process technology from the Efficient Separations and Processing Crosscutting Program and the International Program using both AEA Technologies and Russian technology provided through Minatom. In addition, the TFA is using commercially available equipment to demonstrate these processes configured where possible as CPUs and transferring these units to the user programs at the completion of a demonstration. Finally, in keeping with the TFA's programmatic goal of providing integrated technology solutions, the Characterization, Monitoring, and Sensors Technology Crosscutting Program is developing process monitors as part of the process control systems.

The specific technical strategy for cesium removal from alkaline wastes includes leveraging with the Efficient Separations and Processing Crosscutting Program to develop and test new sorbents and resins to evaluate performance. Results from these flow studies have been used to identify the most promising sorbents that are then evaluated on a broader set of waste at ORR, Hanford, and SRS. In addition, processing systems are demonstrated on a large enough scale to obtain operating data. The following technology activities are supported by the TFA for cesium removal in accordance with this strategy.

- Completion of the demonstration of a compact processing unit with crystalline silicotitanate to process 94,635.29 L (30,000 gal) of MVST waste. This was developed by Efficient Separations and Processing Crosscutting Program.

- Evaluation of crystalline silicotitanate and other sorbents to augment the current tetraphenylborate process or provide cesium removal for the DWPF recycle stream (see Problem Element 1.1.4) for SRS through Efficient Separations and Processing Crosscutting Program. Information will transfer to TFA in later years for addressing high-priority cesium removal needs of SRS.

- Development of process monitor to detect and measure cesium in process effluents through the Characterization, Monitoring, and Sensors Technology Crosscutting Program.

The technical strategy for TRU, cesium, and strontium removal from acidic wastes is to provide performance and engineering data to INEEL users on solvent-extraction and ion-exchange processes to confirm their baseline process assumptions, support the record of decision, and support Title 1 Design. The following activities are being performed.

- Demonstrate TRU and strontium solvent-extraction processes at the Idaho Chemical Processing Plant (ICPP) with actual wastes.

- Develop an integrated cesium solvent-extraction process through the Efficient Separations and Processing Crosscutting Program for consideration as part of the INEEL flowsheet.

- Test the Russian Cobalt Dicarbollide process through the Efficient Separations and Processing Crosscutting Program as an alternative cesium and strontium separations process for INEEL.

- Develop and test an engineered form of ammonium molybdophosphate (AMP) ion-exchange material for INEEL cesium separation through the Efficient Separations and Processing Crosscutting Program.

The technical strategy for technetium removal from Hanford wastes starts with collection of baseline process information on commercial anion exchangers and then extends to waste types and process alternatives for which these anion exchangers cannot be used. Testing of commercial systems is being completed in FY97. Evaluation of process alternatives for removal of nonpertechnetate species is continuing through the Efficient Separations and Processing Crosscutting Program. Additional technetium speciation data will be obtained through this effort.

Problem Element 1.2.2.7 Process Sludge. After solid-liquid separation, the sludge is processed to remove excess chemical species that either increase the volume of HLW or adversely impact the performance of the HLW form. Because there is a high cost associated with the number of glass logs produced, improvements in sludge processing that lead to a reduction in glass logs has a significant potential for cost reduction during waste processing. Sludge chemistry is complex, and users prefer sludge washing and leaching tests be conducted on actual wastes from their tanks to develop flowsheets and process requirements. The baseline technology for sludge at the four sites is summarized here. At SRS, the baseline technology consists of leaching and washing steps; these operations are conducted in tanks in batch operations. Improvements in equipment, such as continuous washing that improves settling characteristics of the washed sludges, could reduce cost at SRS. Sludge process requirements are not yet defined at ORR, although some of the TFA work has been conducted historically on MVST sludges giving the site some data to assist in setting requirements in the future. INEEL has little sludge given the acidic conditions; hence, sludge

washing is not an issue for that site. Hanford is developing the baseline process assumptions at this time.

The technical strategy for processing sludge includes process chemistry for Hanford, process equipment development for SRS and Hanford, and process monitors for process control. The process chemistry work is directed predominantly at the completion of the Hanford baseline and enhancements or alternatives to that baseline that could significantly reduce cost. The baseline work (referred to as enhanced sludge washing) has been carried out in a prescribed manner for a broad range of Hanford waste types. The temperature and number of caustic wash steps along with the analytical requirements for the residual sludge and wash solutions are set by the users. Consequently, these tests provide the user with the ability to compare results for many waste types and allow them to confirm or amend assumptions about the Hanford flowsheet. These results are reported annually to the Washington State Department of Ecology and are scheduled for completion in FY97. Furthermore, these results establish baseline data against which enhancements and alternatives to sludge processing can be compared.

The enhancements to this baseline process chemistry include altering the range of temperature and pH of the washing solutions. This work is conducted on the same sets of samples that were used to obtain baseline process data for direct comparison of the baseline and enhanced methods. Conditions that lead to improved removal of important constituents during the washing process or to the formation of gels that are detrimental to sludge processing efficiency are identified. The alternatives to the baseline process chemistry include selective leaching of critical species such as chromium, phosphorus, and aluminum from sludges using various leaching solutions and conditions. TFA activities will focus on the following.

- Evaluation of caustic dissolution behavior of various Hanford sludge components to support the March 1998 Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) milestone and to recommend processing parameters for Phase I privatization (extended quantity order) and Phase II RFP decisions.

- Evaluation of chromium removal performance during sludge washing and identification of methods (e.g., oxidative leaching and caustic leaching) to improve chromium removal to ensure a baseline exists that can reduce the impact of chromium on HLW glass volume and subsequent immobilization costs.

Problem Element 1.2.2.8 Prepare Pretreated Waste for Immobilization. Pretreated alkaline supernate and sludge are sent to LLW and HLW immobilization processes, respectively. The baseline immobilization process for LLW at SRS and ORR is grout. The baseline process is still being established through privatization contracts at Hanford. The supernate in these alkaline wastes contains large volumes of sodium nitrate. Nitrate concentration impacts the volume of LLW, because it is one of the chemical species driving waste form performance requirements. The sodium nitrate can be converted electro-chemically to sodium hydroxide. In this process, nitrates are destroyed and recovered sodium hydroxide can be reused in the retrieval and sludge washing process steps. Cost

benefit can be achieved due to the reduced volume of grouted waste and the concurrent recovery of sodium hydroxide.

The baseline immobilization process for LLW at SRS is saltstone (i.e., grout). Current separations and LLW feed preparation leaves a waste stream with a higher water content than is necessary for effective saltstone production. A reduction in this water content could significantly reduce the volume of LLW saltstone formed while maintaining a quality LLW product.

The technical strategy to address these problems is to evaluate the options for further pretreatment to reduce costs associated with waste immobilization. The technologies being supported by TFA to accomplish this strategy are

- Salt splitting and membrane separation for caustic recovery jointly supported by Efficient Separations and Processing Crosscutting Program and TFA for consideration at SRS and Hanford; commercial equipment will be explored through Industry Programs.

- Commercially available equipment for out-of-tank evaporation of the saltstone feed stream at SRS to decrease the volume of immobilized LLW produced. Functional requirements will be developed, waste-stream specific processing issues addressed through hot laboratory testing, and an industrial contract placed through Industry Programs to design and fabricate a CPU for demonstration and deployment at SRS.

Problem Element 1.2.3.1.3 Immobilize LLW Stream. The current baseline for LLW immobilization at SRS, ORR, and INEEL is grouting. The baseline for Hanford is being established based on performance requirements set forth in the privatization call for proposals. Glass waste forms are being considered for Hanford and for M Area sludges at SRS. At INEEL, high nitrate levels in LLW feed require development of an appropriate LLW grout formulation and/or denitration process to pretreat the LLW feed. ORR is considering all tank waste in MVSTs to deliver a feed stream to private vendors for treatment, including LLW immobilization. A sound basis for selecting LLW forms and the data needed to make this selection would help the DOE evaluate privatization risks, support design decisions, and would provide stakeholders with better information for considering waste form options.

The technical strategy is to support INEEL with LLW stream pretreatment and immobilization development to support the FY99 record of decision and Title 1 Design for INEEL's unique waste streams, while demonstrating a decision methodology and side-by-side grout and glass process comparisons for ORR LLW that will also have broader benefit to SRS and Hanford. The decision methodology that will be demonstrated has been used in the United Kingdom by AEA Technologies and will be adapted to meet U.S. regulatory and stakeholder requirements through the International Program. Input to these requirements will be gathered from users at multiple sites. Vitrification and grout processes for multiple LLW streams at ORR will be tested to provide data necessary for performance evaluations, privatization proposal evaluations, and design decisions.

Problem Element 1.2.3.2 Process HLW. The baseline technology for HLW processing is vitrification at all of the tank sites with this process being operational at SRS. At SRS, methods that can reduce the cost of operation are being identified and evaluated. Cost reduction can occur through 1) optimization of waste loading that reduces the number of glass logs produced, and 2) improvements in process equipment and materials of construction that reduce maintenance and downtime by reducing corrosion or other materials failure problems. At the Hanford Site, optimized waste loading and melter selection are considerations for developing the baseline to support Phase II privatization, especially with regard to concerns about high chromium wastes and their compatibility with current melter designs and waste formulations. At INEEL, waste formulation for sodium-bearing waste and calcined wastes followed by melter testing is needed to meet an accelerated schedule for the record of decision, and the FY00 Title 1 Design schedule. Corrosion of melter materials from the acidic wastes at the INEEL is a key issue that must be addressed with both formulation and materials development and testing.

Therefore, the technical strategy is directed at waste formulations, equipment enhancements, and advancement in materials. The following activities are supported by TFA.

- Optimize waste loading for components such as iron, aluminum, silicon, zirconium, and alkali cations in SRS and Hanford wastes, and determine solubilities in glass of minor components such as chromium, phosphate, halides, technetium, and actinides to optimize waste loading of these components; jointly funded by TFA and SRS user program.

- Establish glass compositions for INEEL's sodium-bearing and calcined wastes to avoid highly corrosive environments and produce acceptable waste forms.

- Test melters for use at INEEL to ensure compatibility of wastes and materials of construction.

- Develop and demonstrate equipment improvements such as melter pour spout (Florida International University and Clemson) and level and density monitors (Industry Programs) for DWPF process tanks to reduce downtime and increase throughput.

Problem Element 1.3.1 Close Tanks. Closure of radioactive waste tanks has become a key element in the tank sites' baseline plans for reducing mortgage and accelerating cleanup. The SRS is actively closing tanks in FY97, while ORR and Hanford are preparing for future tank closure activities through the GAAT Treatability Study and the Hanford Tanks Initiative, respectively. INEEL is exploring an accelerated schedule for tank closure and will be sampling tank residuals to support future closure decisions. Tank closure activities include sampling or characterization of tank residuals, defining the closure criteria (i.e., asking the question "how clean is clean?", and stabilizing the tank for closure). These three aspects of tank closure are captured in TFA's Problem Elements 1.3.1.2, 1.3.1.3, and 1.3.1.7.

The technical strategy TFA is pursuing is to team with the site users to implement the tank closure activities in conjunction with baseline programs at each site, and conduct integrated demonstrations of sampling and characterization, criteria development, and tank stabilization

to close radioactive waste tanks at each of the sites. Specific TFA activities in each of the tank closure problem elements are described as follows.

Sample & Characterize Heels/Residuals

- Deploy the LDUA at INEEL to sample tank residuals and support strategy development for accelerated tank closure.

- Deploy the LDUA and gripper end effector to move currently used sampling devices to off-riser locations in Tanks 104-AX and 106-C to sample tank residuals.

- Develop and demonstrate vadose zone characterization tools for deployment with the cone penetrometer to support tank farm closure performance evaluations and development of retrieval performance criteria within the Hanford Tanks Initiative.

Define Closure Criteria

- Develop retrieval performance objectives to support the termination of tank closure requirements.

Stabilize Tank for Closure

- Characterization, retrieval, out-of-tank processing, process monitoring, and in situ grouting systems will be used at ORR on the gunite tanks to close the North and South Tank Farms by FY02. Technology from Robotics, Industry, Characterization, Monitoring, and Sensors Technology Crosscutting Programs, and TFA will be used (GAAT Treatability Study). TFA will develop and deploy tools using the LDUA to isolate and plug tank penetrations (e.g., piping) and develop, test, and deploy grout formulations and jet grouting techniques to stabilize gunite tank. The TFA will build off of efforts at SRS in FY97 with Tanks 17 and 20 and provide performance data on jet grouting to support additional tank stabilization activities at SRS, Hanford, and INEEL. Lessons learned from Subsurface Contaminants Focus Area on multiport grout injection for underground structures will also be used.

Problem Element 1.3.2 Dispose of LLW. Product quality assurance is a necessary step in the LLW immobilization process. The baseline LLW immobilization technology for INEEL and SRS is grout and saltstone, respectively, while Hanford is pursuing a glass waste form as part of privatization. Grout and glass waste forms are being evaluated for ORR (see Problem Element 1.2.3.1.3). While product quality assurance is well established for the HLW glass at SRS's DWPF and for the LLW saltstone at SRS, LLW glass for Hanford still requires product quality assurance methods and waste form performance testing to allow for LLW disposal preparations and receipt of LLW glass product from the privatization vendors.

The technical strategy is to develop an integrated plan for evaluating disposal site performance criteria, waste form performance, and product quality assurance data and methods to support Hanford Phase I privatization and ORR LLW immobilization decisions.

The TFA is working with the Hanford user to develop waste form standards and test methods, and to adapt and demonstrate industrial methods for product quality assurance to allow DOE to accept waste product from private vendors.

3.6 TFA Technical Program

The TFA continues to use a phased management approach and technical strategy. The program initially focused on technologies that could be rapidly deployed or meet near-term needs at multiple sites under multiple possible baselines (e.g., privatization). As these technologies progress through demonstration and transition to users, the program continues to shift its focus on technical initiatives that offer greater payoffs with somewhat greater risk.

Therefore the program presented here is focused on continuance of solutions that are carried forward from last year and are on schedule for deployment within site baselines in 1 to 3 years. These near-term solutions emphasize relatively mature technologies, many of which have been developed by EM for several years but may not have received the national, focused attention provided by this program. The solutions are primarily aimed at reducing technical risk and offer enhancements to, or fill gaps in, current site baselines.

The TFA's technology development portfolio provides evidence of its response to its technology development challenge. The TFA's growing experience with this portfolio continues to build a more strategic approach to tanks technology development integration. Four technical strategic goals remain essential to the TFA.

- Demonstrate, deploy, and provide performance data for four systems to meet EM's FY00 tank waste retrieval requirement.
- Provide tank waste treatment technologies that can efficiently pretreat and immobilize 80% of HLW.
- Demonstrate CPUs for HLW treatment and immobilization as a cost-effective alternative to large-scale facilities.
- Provide subsystems necessary to support the closure of 16 radioactive waste storage tanks: Hanford (2), Oak Ridge (10), and SRS (4).

These strategic goals provide a more definitive program focus that ties critical complex-wide requirements to site needs. The TFA's development and execution of technology development tasks will reflect aggressive pursuit of these goals. Figure 3.2 identifies the relationship between these strategic goals and the key EM projects focused on meeting these goals. These key EM projects represent joint TFA and EM-30 or EM-40 site users' efforts to meet high-impact site retrieval, pretreatment, immobilization, and closure needs. The projects are critical to meeting the sites' missions, reducing mortgages, and meeting the TFA's strategic goals.

Specific TFA activities in support of these strategic goals are described within the previously introduced problem element structure shown in Table 3.1. In Table 3.1, the problem elements in bold type indicate those for which the TFA is developing a response to user needs identified in the TFA site needs assessment. Problem element titles, summaries of problem statements and planned work scopes appear in Table 3.2. More detailed descriptions of these problem elements are provided in Appendix B. Each problem element is directly associated with multiple technical activities funded by EM-30, EM-40, or EM-50. Activities that may be leveraged or coordinated in FY98 will be identified and integrated into this plan as EM-30 and EM-40 complete their FY98 planning process. Table 3.3 shows the estimated EM-30, EM-40, and EM-50 funding for each of the technical elements. Section 4 and Appendix B provide additional detail of this integration.

The requested budget for the TFA-managed program is $31.5 million for FY98 and $45.55 million for FY99 (see Table 3.3). This FY99 budget reflects an unconstrained budget estimate. The work scope for FY99 and FY00 identified in this MYPP was based on the unconstrained budget. Therefore, work activities planned for FY99 and FY00 may need to be delayed or rescoped depending on the actual budget level authorized. The TFA-managed program includes activities to ensure integration of complex-wide needs, timely delivery of responsive technical solutions, and leveraging of all available resources to address the national tank remediation priorities. These activities include technical strategy development, technology delivery, and overall program management. Therefore, the requested budget includes annual costs of $6.15 million for these activities.

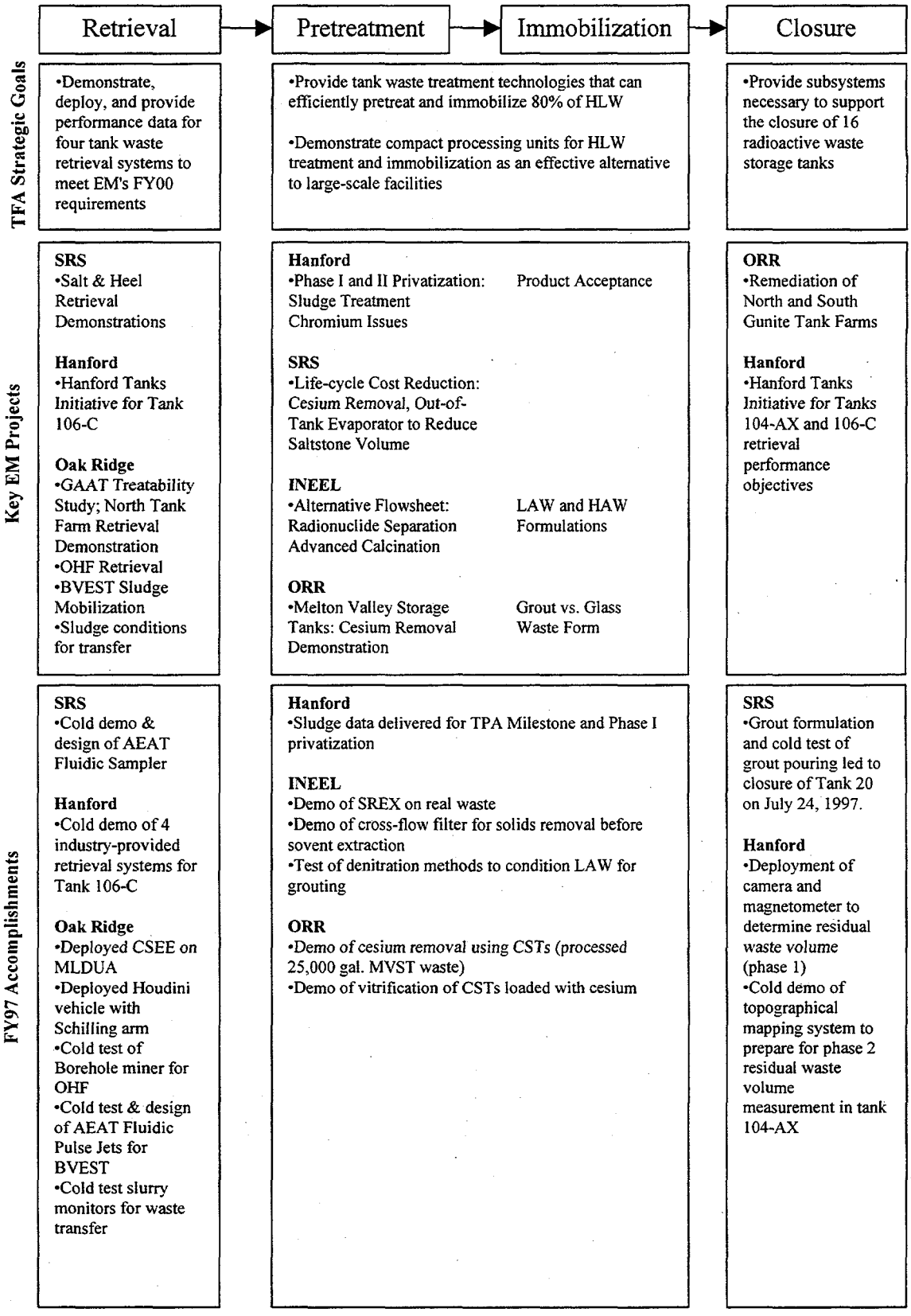


Figure 3.2. Relationship of Tanks Focus Area Goals to Key Environmental Management Projects and FY97 Accomplishments

Table 3.2. Scope of Recommended Tanks Focus Area Technical Program

Problem Element	Problem Statement	Path to Solution
1.1 Store Waste		
1.1.1.1 Monitor Tank Integrity	Real time corrosion inhibitor and corrosion monitoring methods are needed to provide early detection of potential problems that may lead to leakage or structural failure. There is a need to perform nondestructive examination of tank walls to determine structural integrity. Current methods are limited to contact examinations and usually require a cleaned surface and coupling between the head and structure being inspected.	• Develop and deploy an LDUA-delivered end effector for nondestructive examination inspection in Hanford's waste tanks. • Identify and evaluate monitors for $NO_3^-/NO_2^-/OH^-$ to maintain corrosion inhibitor concentrations at SRS. • Demonstrate and transfer electrochemical corrosion probe to SRS and Hanford.
1.1.2 Ventilate Tanks	Waste tank ventilation is necessary to maintain safe operating conditions within the tank farm. However, baseline ventilation systems comprise energy- and maintenance-intensive components. For example, frequent change-out of disposable HEPA filters increases the cost and risk of maintaining safe tank operations.	• Design, select, and demonstrate passive ventilation systems to reduce the O&M costs of active ventilation systems at SRS. • Design and procure regenerable (i.e., washable) sintered metal filter systems to replace HEPA filters within tank ventilation systems at SRS to reduce worker risk and cost.
1.1.3.1 Characterize Waste In Situ	Designing and deploying effective waste retrieval systems for tank wastes requires knowledge of the waste characteristics, such as the volumes and interface between supernate, sludge, and/or hard heel. Methods to map the sludge or heel level are needed for tanks where the bulk supernate remains, to allow for design of the retrieval system and retrieval strategy before supernate removal.	• Develop and demonstrate a sludge mapping tool to measure the volume of sludge present in tanks before and after supernate retrieval at ORR.
1.1.4.2 Reduce Recycle Streams	Tank farms are still receiving wastes even though many major mission operations have ceased at most of the sites. Some of these wastes result from tank-to-tank transfers to solve waste storage problems or from tank waste processing operations. Removal of dilute concentrations of problem constituents could allow these wastes to be discharged rather than being recycled to the tank farms for subsequent costly processing.	• Develop specifications and procure a commercial system for adaptation to the treatment of the Defense Waste Processing Facility recycle stream. • Demonstrate the pilot system at SRS.

Table 3.2. (contd)

Problem Element	Problem Statement	Path to Solution
1.2 Process Waste		
1.2.1.2 Mobilize Bulk and Heel Wastes	The DOE complex has horizontal and vertical cylindrical steel and concrete waste storage tanks that require remediation. Removal of bulk saltcake and sludge, saltcake heels, hard sludge heels, and possibly debris will be required. Alternative approaches to the hydraulic mining baseline are required for retrieval of the hard sludges, or bulk waste retrieval in leaking tanks where water use is restricted, as well as removal of debris and contaminated floor and wall segments. There is also a need for technical support for producing functions and requirements documents and prototypic hardware to allow sites to procure the right equipment.	• Deploy pulsed air and improved jet pump systems to support ORR GAAT retrieval and waste conditioning operations with the MLDUA, Houdini, and Confined Sluicing End Effector. • Demonstrate fluidic pulse jets for sludge mobilization in ORR Bethel Valley Evaporator Service Tanks. • Design and deploy the extendible nozzle/borehole miner to support retrieval of sludges from the ORR Old Hydrofracture Tanks. • Demonstrate and deploy salt dissolution methods for tank annuli and modified density gradient salt dissolution for bulk saltcake at SRS. • Develop performance specifications and procure and test commercial systems for heel retrieval at SRS and Hanford. • Retrieve C-106 heel to support retrieval performance objectives development.
1.2.1.4 Transfer Waste	Waste transfer operations are required after retrieval to support more efficient waste storage, to support a retrieval operation, or staging of wastes for subsequent blending or pretreatment. During transfers, pipeline plugging has occurred and can result in very costly delays and intensive efforts to mitigate the plugging. Pipeline unplugging techniques are needed to mitigate future problems safely and cost effectively.	• Adapt and test commercial systems for pipeline unplugging, and perform side-by-side testing to evaluate the merits of multiple systems. • Develop and deploy waste conditioning CPU - ORNL • Evaluate the effects of physical and chemical conditions on waste rheology and transfer for Hanford, ORR, and SRS waste types and test commercial methods for unplugging transfer lines.
1.2.1.5 Detect and Mitigate Leaks	Measurement of waste tank liquid levels can have accuracies on the order of thousands of liters. Improved methods for leak detection are needed to prevent unplanned release of radioactive waste in the event leakage occurs during retrieval. Leakage during sluicing and other types of waste removal will be an issue with states, regulatory agencies, stakeholders, and sites. Two general types of leak prevention technologies, repair and mitigation, need to be investigated and alternatives evaluated.	• Evaluate state-of-the-art technologies in leak mitigation and repair within DOE, U.S. industry, and internationally. • Develop multiyear program to develop, test, and demonstrate systems for leak mitigation and repair based on user input on performance requirements and the current technology status. • Develop improved tank evaporation monitoring to reduce the uncertainty of current water balance measurements.
1.2.1.6 Monitor & Control Retrieval Process	The physical and chemical properties of the retrieved waste must meet certain operational requirements for retrieval and pretreatment operations to be successful. Transfer line pluggage is a concern for operations, and particle size, weight percent solids, and chemistry changes occurring during retrieval impact the efficiency of the downstream pretreatment operations. Sampling, analysis, and monitoring (e.g., sensors) that can provide these data are needed.	• Develop a multi-level sampling device with at-tank analysis to support feed staging for Phase I privatization at Hanford. • Prepare and downselect several types of on-line slurry monitors for testing and hot deployment at ORR.

Table 3.2. (contd)

Problem Element	Problem Statement	Path to Solution
1.2 Process Waste		
1.2.2.1 Calcine Waste	The INEEL sodium-bearing waste is not compatible with the current fluidized bed calcination flowsheet at 500°C because of incomplete conversion of the nitrates to oxides and the formation of agglomerated particles in the calcine. Alternatives include high temperature processing and sugar additive calcination to improve denitration. In addition, the waste processing baseline plan for INEEL includes a separations flowsheet option that is being pursued, and requires dissolution of calcines before radionuclide separation. Therefore, both technical advancements to support future calcination and developments of methods to dissolve existing calcine are required to meet the processing schedule for INEEL.	• Optimize the calcining flowsheet to handle sodium-bearing wastes through pilot-plant studies. • Evaluate the chemistry and dissolution behavior of calcines and bench test preferred methods to support flowsheet development.
1.2.2.3 Prepare Retrieved Waste for Transfer and Pretreatment	Physical and chemical properties of tank waste can impact the efficiency of pretreatment. Various chemical combinations can lead to gelation or precipitation, which will adversely impact processing. A better understanding of sludge and saltcake chemistry and its impact on dissolution rates, pipeline transfers, and mixing operations is needed.	• Evaluate saltcake dissolution and concentrate re-precipitation phenomena in complex solutions to upgrade thermodynamic models to support retrieval and storage operations at Hanford.
1.2.2.4 Clarify Liquid Stream	Baseline technology for solid-liquid separation does not appear adequate for many of the tank pretreatment waste streams. Testing of alternative filter systems is required to support the separation of undissolved solids from the sodium-bearing and dissolved calcine wastes at INEEL and various LLLW streams at ORR including TRU sludges.	• Obtain performance data on cross-flow filtration to remove undissolved solids from acid waste and to evaluate regeneration with back pulse or non-acid wash at INEEL. • Obtain operational experience on a larger scale system by preparing a hot demonstration on wastes for transfer to Melton Valley Storage Tanks (MVST) at ORR.
1.2.2.5 Remove Radionuclides	Cesium Removal from Alkaline Wastes: Alternative cesium removal technologies are desired for SRS to backup the baseline in-tank precipitation process and allow potential improvements in efficiency and life-cycle costs. For ORR, performance and cost data from actual processing is needed to ensure that deployment of cesium removal using CST is appropriate. Radionuclide Removal from Acid Wastes: Treatment technologies applicable to transuranic elements including strontium, technetium, and cesium in INEEL waste streams must be developed and tested to provide cost and performance data for final baseline technology selection.	Cesium Removal from Alkaline Wastes: • Complete demonstration and transfer the CST removal system for use on cesium at ORR. • Evaluate crystalline silicotitanate and other sorbents to augment the current tetraphenylborate process or provide Cs removal for the DWPF recycle for SRS. Radionuclide Removal from Acid Wastes: • Select appropriate separations processes for TRU, technetium, strontium, and cesium removal. • Test and demonstrate methods for TRU, technetium, strontium, and cesium removal over a 3-year period. • Produce performance and cost data to support INEEL decision on their baseline radionuclide separation unit operations.

Table 3.2. (contd)

Problem Element	Problem Statement	Path to Solution
1.2 Process Waste		
1.2.2.7 Process Sludge	Sludges at SRS, Hanford, and ORR will require processing to remove nonradioactive constituents that either adds to the volume of the resulting HLW (e.g., aluminum) or impacts immobilization processing (e.g., chromium, technetium, or phosphate). Technical problems and issues exist in three areas of sludge processing: performance data on the baseline enhanced sludge washing system, sludge washing chemistry, and continuous sludge processing.	• Evaluate caustic dissolution behavior of various Hanford sludge components to support the March 1998 Tri-Party Agreement milestone and to recommend processing parameters for Phase I privatization (extended quantity order) and Phase II RFP decisions. • Evaluate chromium removal performance during sludge washing and identify methods (e.g., oxidative leaching and caustic leaching) to improve chromium removal. • Study dilution, leaching, and washing of Hanford sludges to identify the operating envelope required to minimize solids formation problems during pretreatment.
1.2.2.8 Prepare Pretreated Waste for Immobilization	Pretreated alkaline supernate containing large volumes of sodium nitrate is sent to LLW immobilization processes. Nitrate concentration impacts the volume of LLW, because it is one of the chemical species driving waste form performance requirements. In addition, current separations and LLW feed preparation at SRS leaves a waste stream with a higher water content than is necessary for effective saltstone production. A reduction in this water content could significantly reduce the volume of LLW saltstone formed while maintaining a quality LLW product.	• Evaluate salt splitting and membrane separation for caustic recovery for use at SRS and Hanford and explore commercial equipment for design and cost analysis. • Design and procure commercially available equipment for out-of-tank evaporation of the saltstone feed stream at SRS to decrease the volume of immobilized LLW produced.
1.2.3.1.3 Immobilize LLW Stream	Disposal of low-activity tank wastes is being approached very differently at individual DOE sites and, in some cases, even within a single site. Specific technical issues and needs exist at the sites for selection of the most appropriate and acceptable waste forms.	• Develop specifications/functional requirements for grout waste formulations for INEEL and grout and glass waste forms for ORR. • Test and evaluate grout formations for INEEL's high aluminum, zirconium, and sodium wastes. • Demonstrate and evaluate grout and glass waste forms for ORR.
1.2.3.2 Process HLW	The baseline technology for HLW processing is vitrification at all of the tank sites. At SRS, methods that can reduce the cost of ongoing operations are needed. Cost reduction can occur through optimization of waste loading that reduces the number of glass logs produced and improvements in process equipment and materials of construction that reduce maintenance and downtime by reducing corrosion or other materials failure problems. At Hanford, optimized waste loading and melter selection, especially with regard to high chromium wastes, are considerations for developing the baseline to support Phase II privatization. At INEEL, waste formulation for sodium-bearing waste and calcined wastes followed by melter testing is needed to meet an accelerated schedule for the ROD, and the FY00 Title I Design schedule.	• Identify methods to optimize waste loading for components such as iron, aluminum, silicon, zirconium, and alkali cations in SRS and Hanford wastes and determine solubilities in glass of minor components such as chromium, phosphate, halides, technetium, and actinides. • Establish glass compositions for INEEL's sodium-bearing and calcined wastes to avoid highly corrosive environments and produce acceptable waste forms. • Test melters for use at INEEL to ensure compatibility of wastes and materials of construction. • Develop and demonstrate equipment improvements such as melter pour spout and level and density monitors for DWPF process tanks to reduce downtime and increase throughput.

Table 3.2. (contd)

Problem Element	Problem Statement	Path to Solution
1.3 Store Waste Forms and Close Tanks		
1.3.1 Close Tanks	Closure of radioactive waste tanks has become a key element in the tank sites' baseline plans for reducing mortgage and accelerating cleanup. SRS is actively closing tanks in FY97, while ORR and Hanford are preparing for future tank closure activities through the GAAT Treatability Study and the Hanford Tanks Initiative, respectively. INEEL is exploring an accelerated schedule for tank closure and will be sampling tank residuals to support future closure decisions. Tank closure activities require sampling or characterization of tank residuals, definition of closure criteria (i.e., asking the question, "how clean is clean?"), and stabilizing the tank for closure. Strategies and methods for accomplishing these activities are needed.	Sample and Characterize Heels/Residuals • Deploy the LDUA at INEEL to sample tank residuals and support strategy development for accelerated tank closure. • Develop and demonstrate vadose zone characterization tools for the cone penetrometer to support tank farm closure performance evaluations and development of retrieval performance criteria within the Hanford Tanks Initiative. • Deploy the LDUA with gripper end-effector and sampling devices to sample off-riser tank residuals in 104-AX and 106-C and support retrieval performance criteria development. Define Closure Criteria • Develop retrieval performance objectives to support the termination of tank closure requirements. Stabilize Tank for Closure • Develop and deploy tools using the LDUA to isolate and plug tank penetrations (e.g., piping) and develop, test, and deploy grout formulations and jet grouting techniques to stabilize gunite tanks at ORR.
1.3.2 Dispose of LLW	Product quality assurance is a necessary step in the LLW immobilization process. While product quality assurance is well established for the HLW glass and LLW saltstone at SRS, LLW glass for Hanford still requires product quality assurance methods and waste form performance testing to allow for LLW disposal preparations and receipt of LLW glass product from the privatization vendors.	• Develop an integrated plan for evaluating disposal site performance criteria, waste form performance, and product quality assurance data and methods to support Hanford Phase I privatization and ORR LLW immobilization decisions. • Develop waste form standards and test methods, and adapt and demonstrate industrial methods for product quality assurance to allow DOE to accept waste product from privatization vendors.

DOE	U.S. Department of Energy	MLDUA	Modified Light-Duty Utility Arm
DWPF	Defense Waste Processing Facility	MVST	Melton Valley Storage Tanks
GAAT	gunite and associated tanks	O&M	operations and maintenance
HEPA	high-efficiency particulate air	ORR	Oak Ridge Reservation
HLW	high-level waste	RFP	request for proposal
INEEL	Idaho National Engineering and Environmental Laboratory	ROD	record of decision
LDUA	Light-Duty Utility Arm	SRS	Savannah River Site
LLLW	liquid low-level waste	Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
LLW	low-level waste	TRU	transuranic

Table 3.3. Recommend

Problem Element	Problem Element Title	FY98$			
		TFA	EM-50 Ind/Int/ Univ	EM-50 Cross Cut	EM 30-
1.1.1.1	Monitor Tank Integrity	395	400	197	
1.1.2	Ventilate Tanks	50	500	0	
1.1.3.1	Characterize Waste In Situ	0	0	0	
1.1.3.3	Analyze Waste	0	0	0	
1.1.4.1	Reduce Source Streams	0	0	0	
1.1.4.2	Reduce Recycle Streams	0	0	125	
1.2.1.2	Mobilize Bulk and Heel Wastes	3775	50	2100	97
1.2.1.3	Mix Waste	0	0	0	
1.2.1.4	Transfer Waste	0	0	0	
1.2.1.5	Detect and Mitigate Leaks	0	0	0	
1.2.1.6	Monitor & Control Retrieval Process	500	0	600	
1.2.1.7	Integrate Retrieval and Pretreatment Technology Systems	0	0	0	
1.2.2.1	Calcine Waste	350	0	0	7
1.2.2.2	Dissolve Waste	0	0	0	4
1.2.2.3	Prepare Retrieved Waste for Transfer and Pretreatment	425	150	0	
1.2.2.4	Clarify Liquid Stream	725	0	0	6
1.2.2.5	Remove Radionuclides	785	0	2080	8
1.2.2.7	Process Sludge	2625	0	350	
1.2.2.8	Prepare Pretreated Waste for Immobilization	525	1000	300	
1.2.3.1.3	Immobilize LLW Stream	2050	200	0	1(
1.2.3.2.1	Monitor & Control HLW Immobilization Process	50	200	0	
1.2.3.2.3	Prepare Sludge Feed	0	0	0	
1.2.3.2.4	Immobilize HLW Stream	1660	0	0	8
1.3.1	Close Tanks	0	0	0	
1.3.1.2	Characterize Heels	2300	0	0	4
1.3.1.3	Define Closure Criteria	7000	0	600	51
1.3.1.7	Stabilize Tank for Closure	1270	0	0	4
1.3.2.1	Monitor Waste for Acceptance	600	0	0	
1.3.2.2	Determine Performance of Waste Form	200	0	0	
Totals:		**31500**	**2500**	**6352**	**243**

Notes: 1) EM-50 Ind/Int/Univ = Industry, International, University; EM-50 Cross Cut = Sum of Charact
Crosscutting Program, and Robotics Crosscutting Program.
2) EM-30 and EM-40 funding data based on available information.
3) All funding estimates are for planning purposes only and are not official funding information.
4) Does not include Environmental Management Science Program (EMSP) or Technology Deplo
5) TFA totals include annual costs for technical strategy development, technology delivery, and

Technical Program Budget ($K)

	FY99$					FY00$					
FY98 Total	TFA	EM-50 Ind/Int/ Univ	EM-50 Cross Cut	EM 30-40	FY99 Total	TFA	EM-50 Ind/Int/ Univ	EM-50 Cross Cut	EM 30-40	FY00 Total	Grand Total
1067	750	425	0	0	1175	450	0	0	0	450	2692
550	600	1125	0	0	1725	600	1075	0	0	1675	3950
0	750	0	0	0	750	700	0	0	0	700	1450
0	1100	0	0	0	1100	750	0	0	0	750	1850
0	525	0	0	0	525	475	0	0	0	475	1000
125	400	500	0	0	900	600	525	0	0	1125	2150
15625	4325	200	0	0	4525	3525	100	0	0	3625	23775
0	900	0	0	0	900	900	0	0	0	900	1800
0	450	900	0	0	1350	650	1525	0	0	2175	3525
0	250	400	0	0	650	300	500	0	0	800	1450
1100	950	500	0	0	1450	950	425	0	0	1375	3925
0	300	0	0	0	300	500	0	0	0	500	800
1080	600	0	0	700	1300	400	0	0	700	1100	3480
414	420	0	0	419	839	600	0	0	643	1243	2496
575	450	0	0	0	450	0	0	0	0	0	1025
1405	1575	0	0	430	2005	1400	0	0	592	1992	5402
3665	1170	0	0	1375	2545	700	0	0	1375	2075	8285
2975	4500	0	0	0	4500	2600	0	0	0	2600	10075
1825	1430	1550	0	0	2980	1600	0	0	0	1600	6405
3250	900	0	0	1000	1900	1150	0	0	1000	2150	7300
250	250	200	0	0	450	350	0	0	0	350	1050
0	200	0	0	0	200	400	0	0	0	400	600
2460	1905	0	0	900	2805	2450	0	0	1100	3550	8815
0	1000	0	0	0	1000	1500	0	0	0	1500	2500
2700	400	0	0	0	400	0	0	0	0	0	3100
12805	10400	0	0	8000	18400	11900	0	0	7000	18900	50105
5770	800	0	0	0	800	150	0	0	0	150	6720
600	1000	0	0	0	1000	1000	0	0	0	1000	2600
200	1100	0	0	0	1100	400	0	0	0	400	1700
64656	**45550**	**5800**	**0**	**12824**	**64174**	**43150**	**4150**	**0**	**12410**	**59710**	**188540**

tion, Monitoring, and Sensor Technology Crosscutting Program, Efficient Separations and Processing

nt Initiative (TDI) funding. See individual problem elements in Appendix B.
am management of $6.15M.

Section 4 – Programmatic Strategy

The objective of the TFA is to build a risk-driven, fully integrated, fully leveraged technology development program that is responsive to user and stakeholder needs for the remediation of radioactive waste tanks. The program is consistent with the 2006 Plan and enables EM to meet their goals for processing waste (e.g., number of canisters per year) and closing tanks (e.g., number of tanks closed per year).

In this section, the strategic intent of the program as well as the implementation and management strategies for achieving this objective are presented and discussed. For reference, the conceptual model for leveraging resources and coordinating tank technology investments across EM that is used by TFA is illustrated in Figure 4.1.

4.1 Strategic Intent of the TFA Program

The TFA is risk-driven - The only reason to invest in technology development activities is to reduce the risks associated with cleanup. These include the environmental, safety, and health risks to workers and the public; ecological risk to the environment; cost and schedule risks; programmatic risks; and technical risks. The strategic intent of the TFA is to work closely with the EM-50's Risk Program, the tank site user programs, and STCGs to develop a risk-based prioritization of needs, and to make technology investments in response to those needs.

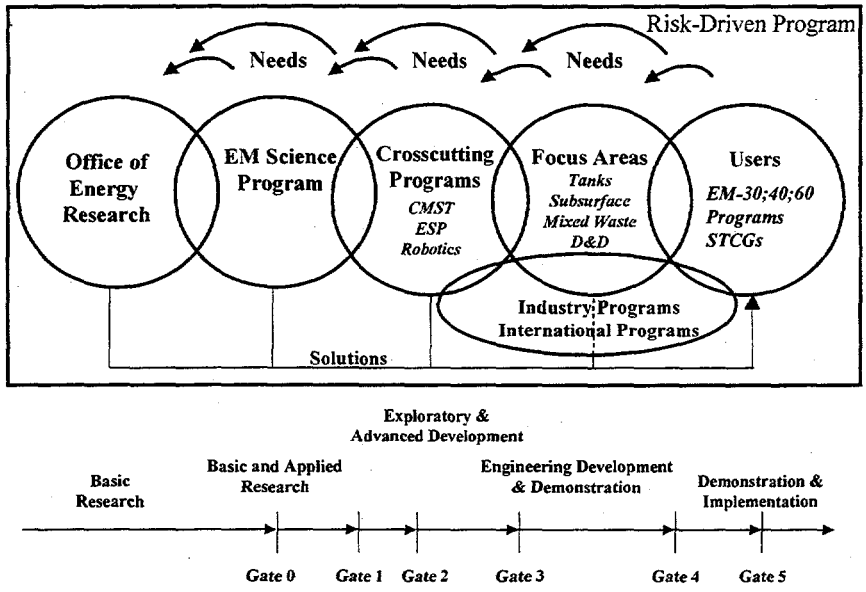


Figure 4.1. Tanks Focus Area Conceptual Strategy Model

The TFA is fully integrated - The TFA is organized around problem elements that describe site technical needs as a system and not individual unit operations. These problem elements are designed to achieve the greatest multisite benefit from the resulting technology investments. The strategic intent of the TFA is to develop technology for integrated multisite systems solutions (see Section 4.3).

The TFA is fully leveraged - In the model illustrated in Figure 4.1, each element in the technology maturation cycle (see Section 4.2) is linked to the elements on either side and to the DOE's industrial and international outreach programs. Moreover, the "downstream" programs are the customers for the "upstream" programs. For example, the users are the customers for the focus areas, while the focus areas are the customers for the crosscutting programs. Needs flow upstream from the user, while science and technology solutions flow downstream to the user. However, users are the ultimate customer and can directly benefit from any "upstream" program. The strategic intent of the TFA is to leverage every available science and technology investment made by DOE and in doing so, engage the entire intellectual capacity of the nation in solving this problem (see Section 4.4).

The TFA is responsive to user and stakeholder needs - In addition to the development of a risk-based prioritization of user needs as discussed previously, the TFA's strategic intent is to work in partnership with site users and stakeholders. Partnerships with site users are established through the Management Team, HLW Steering Committee, and USG. Partnerships with stakeholders are established through the STCGs. These partnerships ensure science and technology investments are implemented (see Section 4.3).

4.2 Managing Technology Development

The TFA has implemented the stage-gate approach (see Figure 4.1) to managing the progress of technologies from development through deployment. In this framework, specific criteria exist for a technology to progress from one maturation level (or "stage") to the next by passing through a "gate." These gate criteria focus decision-making on specific technical and programmatic issues, foster early user involvement, and provide conspicuous decision and review points. Table 4.1 shows the technology maturation levels of the TFA technical activities proposed for funding in FY98.

As is clear from Table 4.1, the TFA funds no activities within the basic and applied research levels. However, these activities have enormous risk reduction potential if successful and should be supported by the relevant DOE programs, as shown in Figure 4.1. The TFA works with the crosscut programs and EM Science Program (EMSP) to translate user needs to longer term science and technology needs to be addressed by them. A more complete discussion of the coordination and leveraging of science and technology investments appears in Section 4.4.

The use of technology maturity levels permits logical management of limited resources where promising technologies pass through "gates" from stage to stage. Similarly, the use of these criteria identifies investments that should be curtailed or abandoned. For example, a

Table 4.1. Technology Maturity Levels for FY98 Tanks Focus Area Technical Activities

Technology Level	Exploratory Development	Advanced Development	Engineering Development	Demonstration	Implementation
Technical Activity		• Studies of Saltcake Dissolution and Concentrate Reprecipitation • Control of Leachate Solids Formation • Parametric Studies of Hanford Sludge Washing • ILAW Form Release Test	• Waste Loading Improvements for HAW Glass • GAAT Tank Closure • TRUEX/SREX for Idaho Pretreatment • $NO^-_3/NO^-_2/OH^-$ Probe (Raman) • Waste Form Product Acceptance Testing • CUF SLS for Idaho • LAW Waste Form for Idaho (Grout) • Enhanced Sluicing Systems Nozzles/Pumps • Enhanced Sluicing Systems - Integrated Retrieval System • Grout & Glass Waste Forms for ORR • Process for Idaho HAW Immobilization • OTE Deployment for SRS • Metal Filters for Waste Tank Ventilation • Variable Depth Fluidic Sampling and Analysis • GAAT Tank Isolation • DWPF Process and Pour Spout Enhancements • DWPF Level and Density Monitors • Advanced Calcination for Idaho • Calcine Dissolution • Waste Conditioning for Transfer • Caustic Recovery and Recycle	• Salt Removal Systems - Annulus Salt • Salt Removal Systems - Density Gradient • HTI Retrieval Tools • HTI - Vadose Zone Characterization • Corrosion Probe - Hanford & SRS • SLS for Melton Valley Storage Tanks • Borehole Miner - OHF • Heel Retrieval for SRS - Type IV • Heel Retrieval for SRS - Type I & II • Heel Retrieval for SRS - Chemical Cleaning • Pulse Air for GAAT Retrieval • GAAT Wall Coring • GAAT Sludge Mapping Tools • LDUA Deployment at Idaho • Slurry Monitors • Waste Conditioning CPU	• AEA Pulse Jets • Cesium Removal Demonstration • Jet Pump for GAAT Retrieval
Gate	2	3	4	5	6
Criteria to State	• *Address DOE need to enter technology* • *Indicate complementary or redundant efforts*	• *Address focus area need* • *Identify/address feasibility* • *Identify user needs/wants* • *Competitive product analysis* • *Identify ES&H issues* • *Identify stakeholder issues*	• *DOE deployment strategy and schedule* • *Product/system integration specifications* • *Manufacturability issues* • *Partnership assessment* • *Cost/benefit analysis* • *ES&H compliance strategy in place* • *Regulatory compliance strategy*	• *DOE deployment strategy and schedule* • *Resolution of technical issues* • *Cost and performance validation* • *ES&H issues satisfied* • *Public issues resolved* • *National Environmental Policy Act permits for demonstration*	• *EM-30/EM-40 procures technology* • *Public acceptance* • *National Environmental Policy Act permits for deployment*

CPU	compact processing unit	ES&H	environmental, safety, and health	LAW	low activity waste	SREX	strontium extraction
CUF	cells unit filter	HAW	high activity waste	ORR	Oak Ridge Reservation		
DOE	U.S. Department of Energy	HTI	Hanford Tanks Initiative	OTE	out-of-tank evaporator		
DWPF	Defense Waste Processing Facility	ILAW	immobilized LAW	SLS	solid-liquid separation		

technology that cannot remain within schedule and budget constraints may be either rescoped, assigned to a new technology performer, or funding may be discontinued. Each time a technology passes through a gate, all previous gate criteria must be satisfied. Therefore, a technology passing from engineering development to demonstration must pass all of the gate criteria from basic research through demonstration.

Table 4.1 presents a comprehensive view of the TFA recommended program in terms of the stages and gates a technology must pass through before implementation. Because the maturity of each technical activity is reflected by its position, the more mature elements that address more urgent site needs are shown to the right. Less mature technologies that have longer lead times (but can typically offer high payoffs as alternatives to the baseline solutions) are shown to the left. Specific technology schedules and other performance parameters are provided in technical task plans supporting the TFA.

Passing through a gate marks an important technology milestone. A typical TFA-funded activity is in Stage 4 (engineering development) or beyond and must be matched with an identified tank remediation need. At some point such activities have passed Gates 2 and 3 and provide "proof of technology," where the exploratory development stage resulted in product definition and the advanced development stage produced a working model. Therefore, while the TFA normally adopts technologies in the later maturity levels, earlier gate criteria serve as critical checkpoints that still must be met.

At Gate 4, technologies progress from proof of technology to an engineering prototype in the engineering development stage. Hence, this is the gate through which most activities enter the TFA. Any technologies that enter before passing Gate 4 must pass it quickly to remain in the TFA. Scaled-up prototype versions, pilot-scale tests, and field testing are characteristic of the engineering development stage. Passage through Gate 5 to the demonstration stage means that a technology will then be validated by the user along with full-scale testing. Finally, Gate 6 leads to implementation (first production or operations), where the user implements the technology. To date, 15 technologies have made it to first production or operations (see Table 4.2).

General criteria for passage through the gates are shown in italics in Table 4.1. These will be tailored to each technology and, once agreement is reached with users and stakeholders, will be incorporated into applicable technology task plans for that technology.

The TFA recognizes more work must be done to fully benefit from managing the level of technology maturity. During FY96, the TFA began managing technical activities using the technology maturity levels concept. Technology groupings, or technical elements consisting of one or more individual technologies, were categorized into a maturity level. The TFA's current program reflects increased maturity level management at the technical activity level, and the TFA intends to emphasize this further next year.

Table 4.2. List of Tanks Focus Area Technologies in Operation/Production Through FY97

Technology Name	Site	Year
1. Acoustically Monitoring the Stirring of DST-241-101-SY	Hanford	1994
2. Borehole Miner	Oak Ridge	1997
3. Cesium Removal Using Crystalline Silicotitanate	Oak Ridge	1994-
4. CSEE	Oak Ridge	1997
5. Laser Ablation/Mass Spectroscopy (LA/MS)	Hanford	1996
6. LDUA Decontamination System	Hanford	1996
	Oak Ridge	1997
7. LDUA - Supervisory Data Acquisition and Supervisory Control System	Hanford	1996
	Oak Ridge	1997
8. LDUA - Viewing Systems	Hanford	1996
	Oak Ridge	1997
9. LDUA	Hanford	1996
	Oak Ridge	1997
10. Lightweight Scarifier	Oak Ridge	1997
11. Mobile Evaporator	Oak Ridge	1996
12. Near Infrared (NIR) Spectroscopy	Hanford	1996
13. Remote Viewing System	Hanford	1996
14. Topographical Mapping System (TMS)/Laser Range Finder (LRF)	Fernald	1992
15. In-Tank Grouting/Tank Closure	SRS	1997

4.3 Site Deployment Strategy

The TFA integrates technologies and information to provide benefits to multiple sites, by identifying and analyzing site needs and matching technical solutions to them. It identifies primary and secondary benefiting sites for each problem element proposed for funding, as shown in Table 4.3. Sites receiving primary benefit are indicated by a dark-shaded box, and secondary benefit sites are indicated by a lighter-shaded box. A blank box has two possible meanings: 1) the site need is not relevant to that site or 2) the need is already met at that site; i.e., a solution has already been demonstrated or applied there. Table 4.3 shows deployment at multiple sites for each problem element. It is a major strategic challenge, requiring a combination of general strategies and detailed technical plans. The TFA supports strategies to enhance cross-site cooperation, including retrieval and transfer of waste samples, waste simulant development, multi-state agreements among regulators, and user visits to other sites to observe applicable demonstrations.

A fundamental operating approach used by the TFA is formation of a user-producer-developer team for each task to ensure that the

- User performance, functional, and schedule requirements are incorporated at the earliest possible juncture for each task (e.g., scope development that becomes part of a call for proposals or program execution guidance).

Table 4.3. Site Implementation Strategy of Problem Elements

Problem Element	Site Implementation Strategy			
	Hanford	INEEL	ORR	SRS
1.1.1.1 Monitor Tank Integrity	■	▒		■
1.1.2 Ventilate Tanks	▒			■
1.1.3.1 Characterize Waste In Situ	▒		■	■
1.1.3.3 Analyze Waste	■			
1.1.4.1 Reduce Source Streams		■		
1.1.4.2 Reduce Recycle Streams				■
1.2.1.2 Mobilize Bulk and Heel Wastes	■		■	■
1.2.1.3 Mix Waste	▒			
1.2.1.4 Transfer Waste	▒		▒	■
1.2.1.5 Detect and Mitigate Leaks	■			
1.2.1.6 Monitor and Control Retrieval Process	■		■	▒
1.2.1.7 Integrate Retrieval and Pretreatment Technology Systems	▒			
1.2.2.1 Calcine Waste		■		
1.2.2.2 Dissolve Waste	▒	■		
1.2.2.3 Prepare Retrieved Waste for Transfer and Pretreatment	■		■	▒
1.2.2.4 Clarify Liquid Stream	■	■	■	
1.2.2.5 Remove Radionuclides	▒	■	■	■
1.2.2.7 Process Sludge	■			■
1.2.2.8 Prepare Pretreated Waste for Immobilization	■			■
1.2.3.1.3 Immobilize LLW Stream	▒	■	■	
1.2.3.2.1 Monitor and Control HLW Immobilization Process				■
1.2.3.2.3 Prepare Sludge Feed				■
1.2.3.2.4 Immobilize HLW Stream	■	■		■
1.3.1 Close Tanks		▒		
1.3.1.2 Characterize Heels	■	■	■	
1.3.1.3 Define Closure Criteria	■	▒	▒	▒
1.3.1.7 Stabilize Tank for Closure	▒	▒	■	▒
1.3.2.1 Monitor Waste for Acceptance	■		▒	
1.3.2.2 Determine Performance of Waste Form	■	▒		▒

Legend:
- ■ Primary benefiting site
- ▒ Secondary benefiting site
- □ Problem not applicable to or already resolved at site

- User becomes a partner with a stake in the outcome of the task by providing timely input and review to the progress of the task and prepares to incorporate the technical solution into the site baseline (e.g., the fundamentals for a deployment plan).

- Developer understands the key technical data required to bring technology to fruition.

- Developer has the opportunity for dialog with the user and producer of goods and services early enough in the development cycle to ensure success.

- Producer is part of the team to ensure that experience from industry is incorporated into the task early.

- Producer understands the user requirements and technical as well as programmatic constraints so that they can be successful in providing the new goods and services to the users as deployment and implementation proceed.

The TFA uses this approach not only for the TFA directly funded tasks; this is also the approach the TFA uses with the crosscut, industry, and other focus area partners with whom the program interacts for a fully leveraged program. Deployment plans and memorandums of understanding will formalize the TFA's commitment to user, producer, and developer partnerships across sites regarding test variables and results that must be obtained to meet multisite requirements and ensure technology implementation.

To date, memorandums of understanding have been used at Hanford to deploy Advanced Hot Cell Analytical Techniques (FY95) and at ORR to deploy the Confined Slucing End Effector, Modified Light-Duty Utility Arm, Out-of-Tank Evaporator, and the Cesium Removal Unit (FY96 and FY97). Agreements through other approaches have been made at SRS to deploy the Fluidic Sampler, at ORR to deploy the Pulse Jet and Borehole Miner, and at INEEL to deploy the Light-Duty Utility Arm and Sampling End Effector (FY98).

4.4 Leveraging and Coordinating Technology

The TFA seeks to maximize the benefit from the DOE investment in tank-related science and technology by leveraging or coordinating – that is, where organizations doing similar work integrate their scopes and budgets to realize greater benefit. "Leveraged" means doing this formally, linking technical task packages or activity data sheets across performing organizations. "Coordinated" means doing this informally, acknowledging the relevance of related tasks by sharing data and/or facilities. The TFA uses high-impact risk-reduction needs to identify corresponding multisite activities that could be more efficiently performed through leveraging or coordinating aggressively. Budgets saved by refocusing related scope would then be free to address other high-priority (perhaps site-specific) items.

In FY98, the TFA envisions that it will be responsible for scope, schedule, and budget of EM-50's tanks program described in this MYPP. The TFA will coordinate tank-related work conducted by EM-50 crosscutting programs as well as related work being conducted by other

focus areas and by each of the site's EM-30 or EM-40 programs. The TFA envisions greater management of a single focused program that crosses organizational boundaries with the TFA-managed scope covering tank technology work with potential multisite applications. While site-specific technology will continue to be managed by each site, the TFA will be cognizant of all tank technology activities within EM to maximize beneficial coordination across sites and support site negotiations and manage technical uncertainties with practical technical expertise.

The strategy for developing leveraged or coordinated activities is presented in Sections 4.4.1 through 4.4.5.

4.4.1 Other Focus Areas and Crosscutting Programs

As much as possible, the TFA remains cognizant of the activities in the other focus areas – Subsurface Contaminants; Mixed Waste; and Decontamination and Decommissioning – to ensure it does not duplicate effort. Furthermore, the TFA actively engages the EM-50 crosscutting programs – Efficient Separations and Processing; Characterization, Monitoring and Sensor Technology; and Robotics. The TFA is the customer for tank technologies developed in these programs and facilitates its transition through the stage-gate framework from development to implementation. As such, the TFA requests support in areas consistent with its priority tasks (see Appendix C) and actively works with these program partners to review and transfer these technologies.

This leveraging requires joint, timely planning, and technical team leadership by the TFA and focus area/crosscutting program in the following four activities.

- **Program Scope Boundaries** - Define technical scope boundaries between programs to minimize overlap of work scope and maximize leveraging of resources.

- **Program Definition** - Participate in the definition of specific technical program work scope, through activities such as joint proposal selection. This definition will ensure proper coordination and the smooth transition of relevant scope from the focus area/crosscutting program to the TFA at the appropriate time. Relevant scope is defined using the stage-gate framework.

- **Program Execution** - Facilitate the coordination of relevant technical tasks, ensuring that principal investigators have the necessary resources for sharing the results of their research and development. In addition, the TFA can facilitate the interaction with focus areas and crosscutting programs' principal investigators and the cognizant technical staff of the users.

- **Program Review** - Participate in the technical peer review of program technical activities, ensuring that the relevant technical activities are appropriately focused and making progress toward implementation.

This leveraging will be implemented as described below.

- **Program Scope Boundaries** - The Technical Team and program coordinators representing the focus areas and crosscutting programs will work to define appropriate technical work scope boundaries.

- **Program Definition** - The Technical Team will participate with the program coordinators of the focus areas and crosscutting programs in the screening and review of proposals for crosscutting program definition. Likewise, the crosscutting program coordinators participate in the screening and review of proposals resulting from joint calls for proposals. Finally, the Technical Team and program coordinators of the focus areas and crosscutting programs will target crosscutting program tasks relevant to the TFA and assist the principal investigators in developing action plans for evaluation and, if appropriate, transfer of work scope to the TFA.

- **Program Execution** - Through joint calls for proposals, the TFA and focus areas and crosscutting programs may jointly fund technical activities. The coordination of these and other appropriate technical tasks is the responsibility of the TFA Technical Integration Coordinator, appropriate Technology Integration Managers, and the relevant program coordinator for focus area/crosscutting programs.

- **Program Review** - The TFA Strategic Integration Coordinator, Technical Integration Coordinator, and Technology Integration Managers (as appropriate) will participate as full members of the focus area/crosscutting program's technical review group. Likewise, the program coordinator for focus area/crosscutting programs will participate as a full member of the TFA proposal review group.

Barriers to the implementation of this leveraging strategy still exist. Through the implementation tactics described above, special attention will be given to these issues:

- **Program Scope Boundaries** - Currently, the role and mission of the crosscutting programs relative to the EMSP and the focus areas are ill-defined. There is no overall understanding of, or guidance for determining, how these programs should interact. Moreover, the timing of the current system of program development (e.g., program execution guidance) does not allow for this kind of interaction.

- **Program Definition** - Each of the focus area/crosscutting programs determine their scope boundaries, and hence define their programs, very differently.

- **Program Execution** - There is a need to formalize the concept of the TFA as one customer for dual-use technologies developed in other focus areas. Tank-related crosscutting program technologies may be transferred to the TFA at the appropriate time through the development and use of action plans.

- **Program Review** - This interaction also needs to be formalized and generalized to all of the focus area/crosscutting programs.

4.4.2 Industry and Industrial Programs

A goal of the TFA is to use industrial partners to deliver commercially available technology into the hands of the site users. By this process, upon successful completion of a TFA demonstration, the user will have a technology that is backed by industry and can be immediately implemented.

The TFA has established a standard procedure that fosters timely solicitation of proposals to meet TFA objectives, as well as the assurance of equitable and secure proposal handling and evaluation. It is critical that the TFA reach out to all viable proposers, deal fairly with all proposals, maintain control of the proposals, and respond appropriately to all proposers. To accomplish this goal, the TFA develops and maintains a Performers Selection Strategy throughout the fiscal year (see Section 2.2). This strategy anticipates technical work required during the upcoming fiscal year, along with an estimate of where the "best and brightest" performers are located, inside and outside the DOE complex. Where the private sector or multiple organizations within the DOE complex are deemed best, formal solicitation for their capabilities may be engaged through a general call for proposals. Where the TFA can demonstrate that only one organization has a particular required capacity (expertise), a directed call to that organization will be used.

The TFA offers certain technical work to the private sector for competitive bid. Work identified in this category is described in technical requirements packages, which are prepared by the TFA Technology Integration Mangers (TIMs). The results of this definition are contained on the TFA homepage (http://www.pnl.gov/tfa/) in both a need statement and a technical response. See Appendix C for TFA's request to Industry Programs for specific program support.

Industry's cooperation with TFA is secured through DOE internal contracts or DOE external competitively bid industrial contracts. The former process historically involved a DOE internal bid consisting of a consortium of industry, management and integration (M&I) contractor, management and operations (M&O) contractor, national laboratory, or a university with a DOE grant. Internal partnering has occurred when an existing DOE contractor solicits a partner for co-bidding a DOE project, or an industrial company approaches an existing DOE contractor to partner on an internal DOE solicitation for bids. The response to these calls must come from the DOE contractor who represents the consortium. Normally, these calls are limited to M&Os, M&Is, national laboratories or DOE funded universities.

Direct external contracts between TFA and industry are secured through a specific site procurement office (DOE or contractor) or through the DOE Federal Energy Technology Center (FETC) procurement office. The TFA does not directly request proposals nor do they accept unsolicited proposals either to their management team or any member of the technical

staff. Rather, industrial partners are encouraged to communicate through FETC all proposals, solicited or unsolicited. Response or inquiries to request for proposals (RFPs) solicited through a field office or a support contractor should be directed to the issuer of the request. The DOE operations offices and DOE site contractors follow the Federal Acquisition Regulations and have prescribed contractual procedures, which vary from site to site. Therefore, industry partners are encouraged to become familiar with the requirements of the site of interest before responding to RFPs.

Work that has been designated as "private sector for competitive bid" is defined in a technical specification package, which contains all the material necessary for RFPs. These technical requirements are forwarded to FETC where a RFP is developed by FETC, with support from the respective TIM. Before issuing the call for proposals, FETC issues an intent of solicitation. This notice is advertised in the Commerce Business Daily (CBD) approximately 30 days before the actual call. Additionally, commercial firms may ensure their notification of RFPs by requesting placement on a FETC mailing list. Notifying FETC of their specific areas of interest and capabilities does this.

Jointly FETC and TFA review all responses to TFA RFPs. Technical experts from the TFA or representing TFA (who have no affiliation with the proposers) support the FETC technical review. Review panels include a mix of technical reviewers, user reviewers with technical or program expertise, and representatives of appropriate crosscutting or other related funding organizations. The DOE FETC Contracting Officer Representative (COR) is responsible for the review process and obtaining the final selection decision. The COR is also responsible for the disposition of all inquiries relevant to the review and selection process. Once a contract has been placed through FETC, the TFA will appoint a technical advisor to support the CORs technical representative in oversight of the work. This TFA technical integrator will coordinate with the TFA TIMs and site's user representative to match the site needs with the development of the technology(s).

Periodically, FETC Broad Based Program Research and Development Announcements (PRDA) are supported by TFA. When specific solutions are not readily apparent or when there is sufficient time to develop alternatives to specific site challenges, a PRDA will be entertained. The respective TFA TIMs will draft a need statement, based upon the site needs (contained on the TFA Internet homepage and on the individual site homepages) and forward them to FETC for inclusion in the PRDA. The FETC COR is responsible for the preparation of the full PRDA, including dissemination of the call. The TFA, as described above, will support the review and oversight of contracts that directly support TFA needs.

DOE contractors (e.g., national laboratories) and DOE operations offices may solicit requests for proposals that support the TFA. These calls are usually in support of a sub-system (e.g., controls for the Light Duty Utility Arm), of which the contractor has direct oversight. Commercial firms will be notified either directly based upon a known expertise, through a consortium partner, or through the CBD. To ensure participation, industry participants are encouraged to ensure the sites' procurement offices know their capabilities. A complete list of the TFA's announcements is listed on their homepage.

As discussed in Section 4.2, the TFA is committed to using the stage-gate approach, with explicit go/no-go gate decision criteria, as a guide for implementing this strategy. However, some TFA technology development activities provide information required for technical and programmatic decisions to be made and therefore are not compatible with focused industry decision criteria. These activities are evaluated on a case-by-case basis for exemption from this strategy. The strategic intent of the TFA is to have industry participate in all aspects of the user, producer, and developer team as follows:

- **Industry as User** - The TFA will be opportunistic, facilitating the involvement of industry as a technology user on a case-by-case basis (i.e., vendors have embraced water jet mobilization),

- **Industry as Producer** - The TFA will follow a policy of "buy first" for all technologies at engineering development (Stage 4) or higher. All technologies higher than Stage 4 will be produced by industry unless exempted by the TFA.

- **Industry as Developer** - The TFA will encourage, as extensively as possible, partnering between industry, national laboratories, and universities for all technology development activities below Stage 4.

Since FY96, the TFA has used the following approach to involve industry in its activities.

- **Industry as User** - The identification of opportunities for users, producers, and developers to interact will result from the development and execution of technology business action plans (see Industry as Producer below). In these instances, the TFA will work to facilitate this interaction to speed the implementation of TFA-developed technology.

- **Industry as Producer** - The TFA will

  - Require an actively involved industrial partner, capable of producing material and/or equipment for all demonstrations at Stage 4 or higher, unless exempted by the TFA.

  - Require the development of business action plans for all technologies at exploratory development (Stage 2) and advanced development (Stage 3).

  - Support principal investigators in the identification of partners for demonstrations.

- **Industry as Developer** - The TFA will evaluate the potential responses to new technology needs.

  - For potential responses at Stage 4 or higher, the first call will be to industry, with a subsequent call to national laboratories and universities should no developer be identified.

- For potential responses at Stage 3-4, a call will be issued to national laboratories and universities requiring a business/industrial partner for successful awards.

- For potential responses at Stage 1-2, a call will be issued to national laboratories and universities encouraging the inclusion of a business/industrial partner.

The identification a potential response's stage will be an integral part of the needs identification and prioritization process. General criteria for assessing the potential responses will be developed by the TFA Technical Team, which will assess the response against the criteria. The results will be validated by the USG.

Barriers to industrial participation still exist. Through the implementation tactics described above, special attention will be given to these issues:

- **Industry as User Barriers** - The current environmental, safety, and health and regulatory issues associated with accessing radioactive waste tanks requires that DOE maintain significant control and oversight of implementation scenarios. This limits markets for industrial users; makes the user, producer, and developer coupling more difficult; increases cost; and inhibits producers from entering the market.

- **Industry as Producer Barriers** - The market for tank technologies is small due to the absence or limit to the dual use potential of tank technologies, as well as the relatively limited quantities required in the radioactive tank cleanup market. This drives the TFA to specialty companies operating in niche markets, which typically increases cost, or may result in the inability of the TFA to identify a suitable partner.

- **Industry as Developer Barriers**

  - Limited market potential (as return on investment) and the perception of high investment risk (compared to other technology markets) for tank technologies results in limited capital formation to support tank technology business/industry partnerships.

  - Environmental, safety, and health and regulatory concerns make access to HLW, waste tanks, and radioactive facilities difficult and expensive. This inhibits the ability of industry to demonstrate developed technologies.

  - Once development is completed, time to implementation is potentially measured in decades, further eroding return on investment. A positive side to this is that the market length (this is a 30- to 50-year problem) can be attractive to small firms seeking to establish a steady market share.

4.4.3 International Programs

The TFA's strategic intent for international programs is the opportunistic leveraging and coordination of DOE's foreign investments in technology, performance data, and resources. This is accomplished through joint definition between the TFA and the user of the validated needs, negotiation of scope and deliverables with the international performers, and delivery and implementation of the final equipment to meet the users' schedules. Close cooperation between TFA and the EM-50's International Technology Systems Applications Program has ensured that a suite of technology systems, ranging in maturity from developmental to final implementation, have been available and will continue to be available.

In these unfamiliar and uncertain times for DOE, however, the TFA's international strategy cannot rest on the outdated assumptions of past decades or rely totally on the funding sources of yesteryear. Over the past 3 years, the TFA's work with international partners has diversified and expanded significantly. The use of international cooperative agreements has allowed the TFA to identify and secure technologies that have been demonstrated to function properly under the conditions anticipated in tank remediation.

From partnerships with Russia, TFA has demonstrated technologies used to clean out several full-scale tanks in the Russian Krasnoyarsk-26 site; directed the development of a technology capable of bounding transuranics in a retrievable matrix; and tested U.S. and Russian solid-liquid filters using actual Russian waste. Working with the United Kingdom's (U.K.'s) AEA Technology, Inc., the TFA has secured power fluidic technologies that will be deployed in FY98 to collect HLW samples at the SRS, and clean-out waste from BVEST tanks at the ORR. A new international partner, Argentina, has provided the opportunity to test the viability of vitrification of resins containing high concentrations of organic compounds.

Future international plans for TFA will focus on systems for the characterization, retrieval, and vitrification of HLW. The international partnerships in FY98 will focus on the following:

- **Russia** – The TFA will be proactive in identifying potential uses of the Russian Pulsating Pump and Pulsating Monitor. The cooperation with Russia in the field of vitrification will allow an exchange of lessons learned from their experience with HLW melters (operated within Mayak for 7 years) and potentially share in the development of technologies to improve the characterization of the final glass waste form.

- **AEA Technology** – The use of power fluidics will continue in FY98 as TFA and AEA Technology develop a variety of technology systems for tanks. Additionally, the continued modification of other mature U.K. technologies for U.S. application, together with the experienced gained in its operation, will be pursued by TFA. The identification of a full suite of U.K. technologies applicable to TFA will be pursued during FY98.

- **International Partnerships** – The TFA will continue to pursue partnerships that provide innovative environmental technology that will aid the user in accomplishing the task of

remediation of the U.S. HLW tanks and the waste contained therein. Where appropriate, these international resources will be used to manage the more urgent risks at U.S. tanks sites, secure a safe work place, and help build a consensus on critical issues.

The TFA works in combination with site users and international partners to develop, test, and demonstrate tank remediation technologies. This is usually accomplished under nonradioactive conditions. The implementation will be the responsibility of the site users aided by TFA and their international partners.

4.4.4 EM Science Program (EMSP)

The EMSP was created in 1995 by the 104th Congress (Public Law 104-46) to "stimulate the required basic research, development and demonstration efforts to seek new and innovative cleanup methods to replace current conventional approaches which are often costly and ineffective." The program's Congressionally mandated objectives are to

- Provide scientific knowledge that will revolutionize technologies and clean-up approaches to significantly reduce future costs, schedules, and risks

- "Bridge the Gap" between broad fundamental research that has wide-ranging applicability such as that performed in DOE's Office of Energy Research and need-driven applied technology development that is conducted in EM-50

- Focus the nation's science infrastructure on critical DOE environmental management problems.

Clearly, the integration of these science and technology programmatic assets is critical to the success of both the TFA and the EMSP. Acceleration of the technology development cycle through the integration of science can be done by creating multidisciplinary "technology fusion" teams that will deliver timely solutions to both the short- and long-term environmental problems faced by DOE. The strategic intent of the TFA is to develop strong programmatic and technical linkages between the EM Science Program and all of EM-50's technology development programs as illustrated in Figure 4.1. Currently funded EMSP projects are listed in Appendix C and by problem element in Appendix B.

Interaction Mechanisms. The TFA and the EMSP are working to establish the mechanisms to

- Communicate the appropriate set of tank waste remediation technical needs and requirements to the EMSP and its researchers

- Continue the development, demonstration, and deployment of the research results generated by the EMSP.

Development and Communication of Needs. Through its technology needs collection process, the TFA is working with the sites to contribute to the development of site-specific

science and technology needs that are clearly driven by the users' problems. This ensures that the scientists work on the most critical, high-impact problems.

To assure that the appropriate set of technical needs and requirements are used, the TFA is working to help the EM Science Program

- Develop its calls for proposals based upon site-specific science needs input developed in cooperation with focus areas and the STCGs (for example, Hanford described science needs in its publication, "Hanford Science and Technology Needs Statements, 1997," U.S. Department of Energy Richland Operations Office, Richland, Washington)

- Consider a tighter focus on the need areas contained in the call for proposals so that the program could fund integrated efforts in specific scientific areas that are coordinated throughout the program, rather than single-investigator, single-effort proposals.

Bringing Forward the Results of the EM Science Program. As recognized by the National Research Council (NRC) in their report on the EMSP, it is essential that the successes of the EMSP have mechanisms through which they can impact site remediation programs, and recommends the use of

> "...annual workshops, seminars, and symposia that bring together EMSP [EM Science Program] investigators, program managers from EM [Office of Environmental Management] and ER [Office of Energy Research] (including those in the EM focus areas), site contractors and other 'problem holders,' and, when appropriate, other stakeholders, regulators, and principal investigators (PIs) and managers of other research programs."

The TFA agrees that annual technical meetings of the type described above would be very beneficial to the overall EMSP. The TFA believes, however, that there are additional mechanisms which can be implemented, with minimal disruption to principal investigators and minimal budget impacts, that will greatly foster technical integration between the TFA and the EMSP. For example, the TFA holds technical conference calls within several Pretreatment areas (e.g., sludge processing) where the technology developers from around the country can share their latest results and discuss open technical issues. Including the EMSP principal investigators on these conference calls would have several benefits. The science program participants would learn more about the technical issues and the technology developers would learn the science being done by the EM Science Program.

To ensure that the results of EMSP investigations are carried forward through development, demonstration, and deployment to impact site tank waste cleanup, the TFA will

- Invite EMSP principal investigators doing relevant tank waste cleanup work to participate on periodic TFA technical conference calls

- Distribute the technical highlights and reports generated by the TFA and the EMSP to the relevant principal investigators in both programs, as well as to the other programs in EM-50, to industry, and to the EM-30/40 users

- Invite relevant EMSP principal investigators to the TFA midyear technical review.

Barriers to this integration still exist. Through the implementation tactics described above, special attention will be given to these issues:

- The EMSP is a new program "co-managed" by the Office of Energy Research and the EM, organizations with very different values and cultures.

- The current EMSP execution model funds individual researchers across the nation. This makes it enormously difficult, if not impossible, to develop and direct an integrated effort aimed at the most intractable problems.

- The current EMSP execution model funds individual researchers in both the national laboratories and universities from separate sources of money making the integration of university and national laboratory researchers (who are closer to the issues facing site users and stakeholders) difficult.

4.4.5 Office of Energy Research

The total budget of the EMSP is small compared to overall basic research expenditures made by DOE's Office of Energy Research. The strategic intent of the TFA is to use the EMSP to educate the nation's fundamental research community to the difficult and exciting technical challenges faced by tank cleanup and, by doing so, influence the basic research agenda of DOE to complete the integration of all stages in the technology maturation life cycle, illustrated in Figure 4.1.

4.5 Alternative Tank Remediation Scenarios

The TFA technology investment portfolio is driven by users' and stakeholders' needs. These needs are developed in response to the DOE baseline strategies for tank remediation at the four tank sites. The baseline strategy is waste retrieval followed by waste processing that results in a LAW that is disposed on-site and a HAW that is stored on-site until completion of a federal repository. The programmatic and technical strategies described in this document respond to this remediation scenario but also can be used to meet alternative scenarios that could arise between now and FY00. If there are shifts in the baseline strategies, the technology investment portfolio would be adjusted through a combination of the following:

- continuing ongoing tasks as currently scheduled
- accelerating ongoing tasks
- refocusing ongoing tasks
- developing new scope.

The alternative scenarios that are currently on the horizon include privatization, mortgage reduction, and ES&H risk reduction. The corresponding changes in the technology investments for each of these potential scenarios is summarized in this section along with a description of the process for making the appropriate program adjustments.

4.5.1 Privatization

The DOE is moving toward privatization as an alternative approach to remediating tanks and tank waste. The underlying strategy would be the same; it is the performers of the waste processing to meet this strategy that would differ. Recently a proposal for privatizing treatment of M Area sludges at the SRS was selected. The Hanford Site has selected contractor teams for Phases Ia and Ib of privatization in which supernatant treatment and LLW processing will be conducted (Ia), with the option of HLW processing (Ib). Phase II privatization at Hanford will include retrieval and immobilization of HLW as well as the supernatant processing. Privatization for the MVSTs at ORR is also being pursued with release recently of an RFP.

There are three primary impacts of privatization to the technology development program. First, the technology user will be different. Today, the user is the site field office and management and operations contractor. Under privatization, technology would be selected by the private contractor to meet DOE performance objectives. The user would be DOE and the privateer. The role of the TFA is to develop technologies to a maturity level (gate) that private contractors can take on the risks associated with privatizing the function.

The second aspect of privatization that impacts TFA technology investments centers on the issue of experience with DOE waste types. Part of the purpose of privatization is to maximize use of industrial experience on a DOE problem, hopefully to meet schedules at reduced costs. However, the bulk of industrial experience with nuclear materials is with acid-side processing. Hence, some aspects of alkaline processing, especially processes for the broad envelope of Hanford Site waste conditions, will have elements of first-of-a-kind processing.

The third aspect of privatization that impacts TFA technology investments is feed delivery and product acceptance. These are critical, DOE-owned components of the privatization concept. The DOE must be able to certify feed characteristics, as well as the acceptability of the returning product.

The TFA has, and is, making technology investments to provide additional information on the different ORR and Hanford waste types available to support successful implementation of privatization. At ORR, the use of out-of-tank evaporation, cesium removal processing units, and LLW form comparison work should provide DOE Oak Ridge Operations Office with critical data for evaluating privatization proposals and vendors. At Hanford, the FY98 work described in Section 3.3 is directed at supporting Phase I and II privatization. The LLW immobilization work is specific to Phase I issues. The retrieval systems, retrieval and

pretreatment interface issues, sludge processing, and HLW immobilization work is directed to Phase II issues.

Consequently, the scope of work identified in Section 3.3 would be continued as defined to support privatization at Hanford and ORR. The SRS already has the experience it needs to successfully implement its privatization of M Area sludge processing.

4.5.2 Mortgage Reduction

A key aspect of mortgage reduction is reducing operating costs. These costs can be reduced for every tank or tank farm that is closed. The TFA is focusing its technology investments in identifying those conditions under which DOE, regulators, and stakeholders will consider a tank or a portion of a tank farm ready for closure.

As a result, those activities identified primarily in Problem Element 1.3.1, Close Tanks, would continue to have strong emphasis. The TFA anticipates that work scope in these areas would be accelerated under a mortgage reduction scenario. In fact, TFA technical support has worked with SRS to close one tank and is enabling closure of 3 more tanks at SRS and 10 tanks at ORR by the year 2000. Additionally, the TFA is helping Hanford set the retrieval performance objectives needed to define closure at Hanford post 2000.

4.5.3 Environmental, Safety, and Health Risk Reduction

A key aspect of a scenario in which environmental, safety, and health risk reduction becomes paramount would be the ability to rapidly process tanks that have the highest risk. At the SRS, the DWPF is in operation, but as operating issues arise the TFA is prepared to deliver alternatives that reduce costs. At INEEL, the need to calcine waste for interim storage would be emphasized. The TFA is currently investing in technology to support the alternative calcination process. This work could be accelerated if needed to meet risk reduction requirements. At ORR, CPUs can be used to process waste at tanks without building large, new facilities. The TFA has already provided the OTE and has been providing the cesium removal units in FY97. In addition, the TFA is providing glass or grout performance data to support privatization of a LLW immobilization facility.

At Hanford, the TFA would emphasize deployment of CPUs for clarification of liquids, radionuclide removal, sludge processing, and waste immobilization. The underlying process chemistry for pretreatment would still be required. Hence, technology development described in Section 3.3 that is directed at Hanford needs would continue but would be slightly refocused to emphasize the specific waste types of a high-risk tank. In addition, there would need to be an acceleration of the CPU concept to deploy this process chemistry at Hanford. The enhanced mixing and retrieval technology development would be refocused to emphasize just-in-time retrieval techniques that would allow a single tank or small groups of tanks to be processed at rates consistent with CPUs. The work on the immobilization process would be refocused to consider processing scenarios on a tank-by-tank basis or for small groups of tanks.

A potential added advantage to using the CPU concept at Hanford is the reduction in immediate capital investments for a large facility and a reduction in the annual operating costs, i.e., a smaller, standing labor force is needed to operate a CPU. Although life-cycle costs for smaller individual units may be higher based on user assumptions and corresponding estimates to date, the cost distribution over the years may become the stronger driver in times of constrained budgets. The ability to get high-risk waste processed more rapidly is advantageous.

A second aspect of ES&H risk reduction is assuring the stakeholders that key risk issues have been identified and are being addressed. To accomplish this, characterization technologies are needed to describe tank integrity and waste compositions. Therefore, the technology strategies and investments associated with Problem Elements 1.1.1, Extend Tank Life, and 1.1.3, Characterize Tank Waste, would be accelerated to meet any changes in users' schedules.

A third aspect of ES&H risk reduction is stabilizing and closing tanks, especially at SRS and ORR where wastes are being retrieved. Emptied tanks need to be stabilized to avoid subsidence and to avoid refilling due to in-leakage. The TFA is making considerable investment to rapidly and effectively close tanks at Hanford as well.

Section 5 - References

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Appendix A - Description of DOE's System for Remediating Tank Waste

The U.S. Department of Energy (DOE) stores radioactive waste in tanks at Hanford Site, Washington; Idaho National Engineering and Environmental Laboratory (INEEL), Idaho; Oak Ridge Reservation, Tennessee; and Savannah River Site (SRS), South Carolina. The cleanup of the tank wastes will be very costly and time consuming, especially given the high activity level of the waste. Waste tank cleanup at these sites will cost an estimated $50 billion in constant 1997 dollars. In addition, resulting health and safety risks to workers, the public, and the environment from cleanup exist that must be reduced to the greatest extent possible.

The Tanks Focus Area seeks to select user-driven solutions that reduce cost and risk and resolve regulatory and technical uncertainties. To support this goal, the technical program recommended in this multiyear program plan is based on assessment of the needs and qualitative judgments of the relative costs and risks of tank remediation across the DOE complex.

This appendix describes the currently available site baselines and the technical, cost, and risk data that underlie Tanks Focus Area's program recommendations. Section A.1 reviews the tank remediation systems at Hanford Site, INEEL, Oak Ridge Reservation, and SRS, including tank waste remediation strategies, and lists estimated costs and schedules for tank waste remediation in constant 1997 dollars. Section A.2 reviews system risks. Section A.3 reviews stakeholder involvement and issues at each site. Section A.4 reviews the Tank Focus Area technical response and important considerations for planning purposes. Section A.5 discusses future steps. Section A.6 lists the references used.

A.1 Review of High-Level Waste Tank Programs

The tank waste remediation programs at Hanford Site, INEEL, Oak Ridge Reservation, and SRS are briefly discussed in this section. The review describes the topography, hydrology, and meteorology at each site because these parameters tend to drive public health and safety concerns. The tanks and associated wastes at each site are briefly characterized, and the strategy for remediating tank wastes is described.

A.1.1 Hanford Site Overview

The federal government acquired the Hanford Site in 1943. For the first 45 years, the Site's primary mission was to produce plutonium for national defense and manage the resulting waste. In 1989, all production facilities were shut down and the mission has diversified to include technology development, waste management, and environmental restoration. The

Hanford Site was placed on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). There are several major facility areas requiring cleanup: 100 Areas, 200 Areas, 300 Area, 400 Area, 700 Area, 1100 Area, and 3000 Area (DOE 1995a). Hanford tank farms are located in the 200 East and 200 West Areas (see Figure A.1). In addition to cleaning up tanks, problems include cleaning up or containing billions of liters of liquids discharged to the soil, decommissioning and decontaminating nine production reactors and hundreds of process-related facilities, disposing of stored solid wastes, and removing spent fuel from basins in the 100 Area.

The Hanford Site is briefly described below.

- The Hanford Site occupies 1,450 km^2 (560 mi^2) of a shrub-steppe ecosystem in southeastern Washington State. The Site and surrounding land is semiarid. The Site contains archaeological sites for Native Americans that date back more than 18,000 years.

- The Columbia River, which runs through the Hanford Site, drains the aquifer that lies under the tank farms in the 200 Areas. Contaminant plumes originating in the 200 East Area have reached the Columbia River (Kincaid et al. 1994).

- Currently, hazardous chemicals and radionuclides (nitrates, iodine-129, tritium, cesium-137, plutonium isotopes, technetium-99, and strontium-90) are present at levels that exceed Federal Drinking Water Standards in the groundwater beneath the 200 Areas and in plumes emanating from the groundwater that are moving toward the Columbia River (Dresel et al. 1994).

- Water use at Hanford and the surrounding area is primarily from surface sources; groundwater sources account for less than 10% of total water use (Cushing 1992). The annual precipitation is 16 cm (6.3 in.).

- The rate at which moisture released to the soil eventually reaches the groundwater (recharge rate) below the Hanford Site varies from 5 to 10 cm/yr (2 to 4 in./yr) depending on the amount of precipitation and vegetative cover (i.e., use of barriers reduces the recharge rate to less that 0.1 cm/yr) (Wood et al. 1995).

- The depth to groundwater ranges from about 55 m (180 ft) beneath the former U Pond in the 200 West Area to 95 m (310 ft) west of the 200 East Area. In comparison to groundwater depths, tank depths vary from 11 to 17 m (37 to 57 ft).

- Prevailing winds in the area are from the west-northwest with the northwest and southwest being the next most common directions. The average wind speed is 3.6 m/s (7.9 mi/h). Wind gusts well above average occur in the summer.

- The population within 80 km (50 mi) is approximately 370,000 (RL 1996a; DOE-ID 1995b, Appendix A).

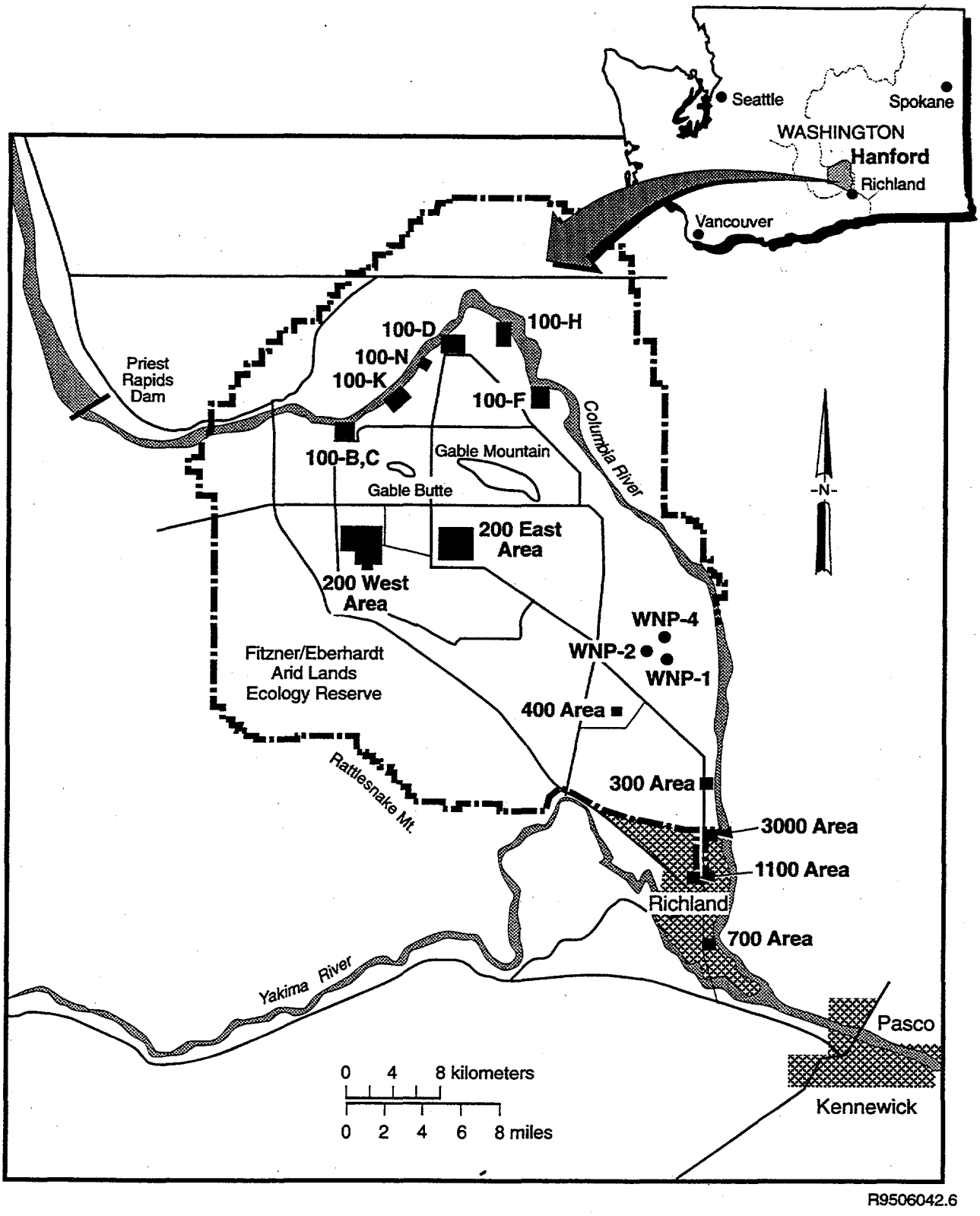


Figure A.1. Hanford Site and Major Facilities

A.1.1.1 Hanford Site Tanks

Wastes are currently stored in 177 underground tanks in the 200 Areas of the Hanford Site. There are 149 single-shell tanks and 28 double-shell tanks. The single-shell tanks, built between 1943 and 1964, are reinforced concrete tanks with carbon steel liners. Nominal capacities range from 200 to 3,785 m^3 (55,000 to 1 million gal). Since 1956, 67 single-shell tanks have leaked or are suspected to have leaked. It is estimated that a total of 3.8 million L (1 million gal) of tank waste has leaked to the soil (Treat et al. 1995). All 149 single-shell tanks were removed from service as of November 21, 1980, and no longer receive any waste. The double-shell tanks were built from 1968 to 1986. The first double-shell tank was placed in service in 1971. Double-shell tanks consist of a carbon steel primary tank, an annular space, and a secondary steel tank encased in reinforced concrete. The nominal capacities range from 3,785 m^3 to 4,160 m^3 (1 million to 1.1 million gal). There is no evidence that any double-shell tanks have leaked, and all of the tanks are still in service.

Some of these tanks are subject to safety issues and the tanks have been placed on watch lists. Specific safety issues that must be addressed include radioactive exposures to both onsite and offsite personnel from a possible release of radioactive materials into the environment due to 1) ignition of flammable gases in tank head space, and 2) uncontrolled exothermic oxidation by nitrate or nitrite of high concentrations of mixed organic chemicals in tank waste. A certain level of moisture may need to be maintained in the tank waste to prevent hazardous conditions from evolving inside these tanks. There is also potential hazard from a structural failure if, in the event of a leak, cooling water additions are discontinued to Tank 106-C, a tank that generates high amounts of heat. A project is underway to remove high heat waste from Tank 106-C and transfer it to a double-shell tank. The project was planned to start in 1997, but it was delayed to excessive heat generation in the sludge.

A.1.1.2 Hanford Site Wastes

Processes used to recover plutonium and uranium from irradiated fuel and to recover radionuclides from tank waste have resulted in a legacy of more than 208 million L (55 million gal) of wastes. Because of the various processes, the waste is found in a variety of layers. Some is an insoluble sludge with interstitial liquids, some is in the form of crystalline water-soluble solids (called saltcake), and some is in the form of supernatant liquids. Most of the pumpable liquids have been transferred from single- to double-shell tanks.

All Hanford tanks contain high-level waste (HLW), the liquid, saltcake, and sludge in single-shell tanks and the slurry in double-shell tanks consist of HLW, transuranic (TRU) waste, and low-level waste (LLW). The total activity of the waste stored is estimated to be about 128.3 MCi in the tank solids and 70.1 MCi in the tank liquids. The principal activity of the waste comes from cesium-137 and strontium-90 and their decay products (barium-137m and yttrium-90). Strontium-90 is largely contained in the sludge, and cesium-137 is soluble and in the supernate. The radioactive contents of the Hanford Site tanks and the tanks at INEEL and SRS are shown in Table A.1. The chemical constituents of the sludge are mostly precipitated sodium salts, heavy metals, and iron, aluminum, and other hydrated metal

Table A.1. Radioactive Content of Tank Wastes at Selected U.S. Department of Energy Sites (Curies)

Radionuclide	Hanford Tanks	INEEL Tanks	INEEL Calcine	SRS Tanks
^{3}H	NA			8.06E+04
^{14}C	4.57E+03			2.00E+01
^{90}Sr	5.95E+07	6.23E+05	1.10E+07	1.19E+08
^{90}Y	5.95E+07	6.23E+05	1.10E+07	1.19E+08
^{99}Tc	3.21E+04			2.28E+08
^{129}I	2.98E-01			3.68E+01
^{106}Ru		3.03E+02	1.87E+03	
^{106}Rh		3.03E+02	1.87E+03	
^{134}Cs		4.48E+03	3.79E+04	
^{135}Cs				
^{137}Cs	3.77E+07	7.34E+05	1.26E+07	1.16E+08
^{137m}Ba	3.57E+07	6.96E+05	1.19E+07	1.10E+08
^{151}Sm	1.07E+06			
^{144}Ce		1.59E+03	7.17E+03	
^{144}Pr		1.59E+03	7.17E+04	
^{147}Pm			6.16E+04	
^{154}Eu		4.16E+03	4.76E+04	
^{238}Pu	1.41E+03			1.71E+06
^{239}Pu	2.63E+04			3.64E+04
^{240}Pu	6.69E+03			1.66E+04
^{241}Pu	9.32E+04			7.53E+05
^{242}Pu	2.80E-01			2.84E+01
^{241}Am	1.04E+05			6.06E+04
^{242m}Am	6.25E+01			6.38E+01
^{232}Th				1.47E+00
^{233}U				1.08E+02
^{234}U				3.01E+01
^{237}Np				7.04E+01
^{244}Cm				2.50E+03
Total	1.94E+08	2.69E+06	4.66E+07	4.67E+08

Source: DOE 1996b.
Notes: **Shaded cells** denote contaminants that are nonsorbing (i.e., move at the rate of water through the vadose zone).
NA is not available.
Blank cells denote that the radionuclide is not contained in the waste.
INEEL = Idaho National Engineering and Environmental Laboratory.
SRS = Savannah River Site.

oxides. Saltcake is primarily sodium nitrate; and the supernatant contains large amounts of dissolved sodium salts, especially nitrates and nitrites.

A.1.1.3 Hanford Site Regulatory or Programmatic Drivers

Regulatory drivers for remediating tank wastes at Hanford are as follows:

- Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1994). This agreement between the U.S. Environmental Protection Agency Region X, the DOE, and the Washington State Department of Ecology established the requirements for meeting federal and state Resource Conservation and Recovery Act regulations. The Hanford Federal Facility Agreement and Consent Order was originally signed in 1989 and then amended in 1994. The amended agreement committed Hanford to retrieval of waste from the single-shell tanks, vitrification of LLW, cessation of the grout program, and National Environmental Policy Act coverage of actions. This agreement serves as the site treatment plan required under the Federal Facility Compliance Act of 1992 (PL 102-386).

- The Hanford Federal Facility Agreement and Consent Order 1996 Amendments (DOE-RL and Ecology 1996b). A Hanford Federal Facility Agreement and Consent Order change package was submitted that recognizes DOE's plans for private financing and operation of the tank waste treatment facilities (Tank Waste Remediation System Privatization Request for Proposal No. DE-RP06-96RL13308 [DOE-RL 1996b]). The change did not affect major milestones for the processing of tank waste, except that low-activity wastes will be treated by 2024 instead of 2028.

- Changes to Hanford Federal Facility Agreement and Consent Order Milestone M-44-00, Tank Waste Characterization. Submitted for public comment on July 15, 1997. This change package will eliminate requirements for sampling a predetermined number of tanks and instead bases characterization on the needs identified by the programs.

- Draft Environmental Impact Statement (EIS) for the Tank Waste Remediation System (TWRS) (DOE-RL and Ecology 1996a). The EIS provides information that has the potential to rebaseline the TWRS program. The environmental consequences of a number of alternatives for treating tank waste, including in situ treatment, are evaluated. A record of decision for the TWRS EIS, signed in February 1997, stated that the phased approach was the best path forward for treating tank wastes.

- Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan (DOE-RL 1996a). DOE has begun developing a land use plan for Hanford to be included in the EIS for Hanford remedial actions. The EIS is to be released in 1996. The plan and the record of decision for the EIS will identify land uses and

accompanying restrictions for major site areas. The future land use currently assumed for the 200 Areas is industrial and/or commercial. This area will likely be held exclusively for disposal, containment, and management of waste, and other compatible uses. Access to the area and use of the groundwater is assumed to be restricted indefinitely.

- TWRS privatization. Contracts were awarded to Lockheed Martin Advanced Energy Systems and British Nuclear Fuels, Limited in August, 1996. Phase I consists of two parts. Part A is a 20-month period to establish the technical, operational, regulatory, business, and financial elements required by privatized facilities. Based on Part A performance, one or more of the contractors will be authorized to perform waste-treatment services for DOE in Part B. Part B is a period of 10 to 14 years during which the authorized contractor(s) will finance, design, construct, operate, and deactivate the waste-treatment facilities. During Part B, fixed unit prices will be paid only for completion and acceptance of waste-treatment services meeting contract specifications. If Phase I efforts are successful, DOE plans a second competitive procurement for Phase II activities. Phase II would be the full-scale production phase, and it is currently expected to begin in 2004. The current Phase II plan involves two competitively selected fixed-price contractors who will finance, design, construct, operate, and deactivate waste-treatment facilities.

- DOE/Ecology Retrieval Performance Objectives Memorandum of Understanding (MOU). The MOU specifies cost, risk and safety as some of the key parameters that must be evaluated in defining the TWRS end-state. The HTI project is providing risk, cost and performance data that will be necessary in establishing the retrieval performance objectives.

- Project Hanford Management Contract. Fluor Daniel, Inc., and its contractors manage and integrate remediation of the Hanford Site. The contract sets many near-term DOE-specified performance measures for tank waste disposal including designing a retrieval system by 2001, providing feed material to the low-activity waste immobilization facility by 2002, and constructing a low-activity waste interim storage facility by 2002. These performance objectives are not negotiable.

- Defense Nuclear Facilities Safety Board Recommendation 93-5 (DOE-RL 1994). The board issued recommendations to accelerate tank waste sampling at Hanford to ensure adequate protection of public health and safety. Safety-related sampling and analysis are to be completed by July 1995 and in other tanks by July 1996. These deadlines have not been met.

- Integrated Vadose Zone Program. A program was established by TWRS to assess risk during waste retrieval, treatment, and closure from leaking tanks. A vadose zone program plan is under development.

- Richland Accelerated Cleanup Plan (DOE-RL 1997). The plan describes how the site will meet existing cleanup agreements. Stakeholders have demanded that the goals of existing cleanup agreements not be compromised. Hanford completes vitrification of tank waste in 2028.

A.1.1.4 Hanford Site Remediation System Description

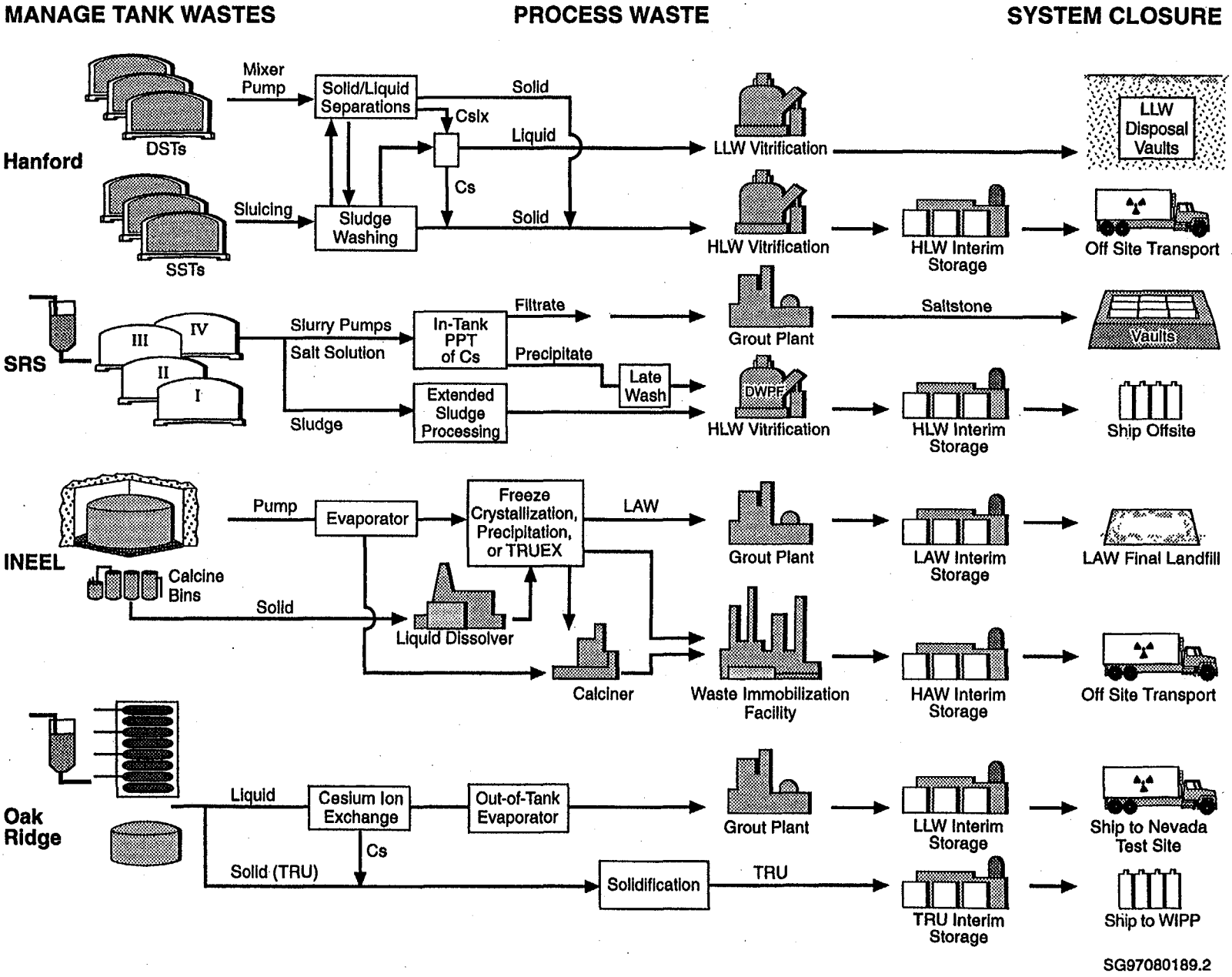
DOE established TWRS in 1991 to oversee 1) receiving, safely storing, maintaining, and treating existing tank waste; 2) interim storage of HLW; 3) packaging of HLW for offsite disposal; and 4) disposing of LLW in a retrievable form on the site. The TWRS program also supports maintaining, operating, and upgrading existing facilities, such as waste storage tanks, evaporators, and pipelines. Tanks Focus Area supports the TWRS program by developing the technologies to accomplish TWRS' mission objectives.

The TWRS strategy is illustrated in Figure A.2. Well-known hydraulic sluicing methods will be used to retrieve single-shell tank wastes, and mixer pumps will be used to retrieve double-shell tank wastes. A substantial amount of secondary waste will be generated as retrieval equipment is contaminated and obstructions (solid waste, old equipment) are removed from the tanks.

Two private companies will design and operate the TWRS facilities that will pretreat and immobilize waste from the Hanford tanks. Privatization will be conducted in two phases. The first phase will use two pilot-scale facilities to treat 6 to 13% of the tank waste. Supernatant will be retrieved and HLW sludges will be pretreated in-tank using water washing and caustic leaching as appropriate. In the second phase, a final contract will be awarded, and a full-scale production facility will be constructed to treat the remainder of the waste. Retrieval will be privatized during the second phase of tank waste remediation (DOE-RL 1996b).

The retrieved liquid waste from the tanks will be pretreated to separate the waste into high- and low-activity fractions. The pretreatment process will use settle/decant to separate solids from liquids. Pretreatment will remove radionuclides including cesium, strontium, and technetium from the liquid waste. These radionuclides will be added to the high-activity fraction of the waste. The DOE has petitioned the U.S. Nuclear Regulatory Commission to reclassify the pretreated Hanford tank waste as low activity (not greater than Class C. The U.S. Nuclear Regulatory Commission has agreed to a low-activity waste classification (58 FR 12344) provided low-activity waste acceptance specifications and tests are developed that prove long-term waste performance. Highly radioactive sludges will undergo caustic sludge washing to minimize glass volume by reducing the concentration of aluminum, chromium, and zirconium in the sludge. The presence of these components on the sludge requires

Figure A.2. Strategy for Remediation of Tank Waste at DOE Sites



additional glass formers be added to make a high-quality glass. The dissolved material will be added to the low-activity fraction of the waste.

The low-activity waste from the tanks will be immobilized into a durable solid waste form, placed in large canisters, and disposed of in near-surface vaults on the Hanford Site. The HLW will be vitrified, put into stainless steel canisters, and shipped in casks to a geologic repository (DOE 1996a). An interim storage facility will be built at Hanford with sufficient capacity to store the entire volume of HLW galss produced by the HLW vitrification facility. Storage will continue until all canisters are shipped to a geologic repository.

A.1.1.5 Hanford Site System Closure

The low-activity waste glass produced at Hanford will be retrievably stored on the Hanford Site in subsurface vaults for several decades. If the low-activity waste disposal system is acceptable, the low-activity waste disposal site will be closed in place (DOE-RL 1995).

Under the Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1994), the tanks will be closed under the State Dangerous Waste Regulations (WAC 1984). The definition of tank includes the tank structure, the residual waste, and the soils contaminated by tank leaks. In 1994 (Wagoner 1994), the responsibility for cleanup of the soils and piping in the tank farm operable units was transferred to the Office of Waste Management. Before closure of the tanks, the U.S. Nuclear Regulatory Commission must agree that the waste remaining in the tanks is non-HLW. The U.S. Environmental Protection Agency is still developing the rules for LLW (40 CFR 193)[a] and residual radioactivity for unrestricted release.

Because of regulatory and technical uncertainties, the tank farm closure strategy has not been finalized. Elements of the proposed strategy include the following.

- Approximately 99% of the waste will be removed from the tanks.
- Tank residuals and ancillary equipment will be left in place.
- Single and double-shell tanks will be gravel filled.
- Surface barriers will be placed over the single-shell tanks, double-shell tanks, and the LLW vaults.
- The tank farms will be subject to Resource Conservation and Recovery Act closure standards for landfills.

(a) Proposed "Environmental Protection Standards for Low-Level Radioactive Waste."

A tank closure plan will be submitted to the Washington State Department of Ecology by December 2004, although a draft plan is available (DOE-RL 1995). The tank closure plan and the National Environmental Policy Act review will determine the closure option and methods of long-term monitoring that will be required for the tank farms after 2032.

The HTI project offers unique opportunity for assisting DOE, the regulators, Tribal Nations and the stakeholders to define and gather data to suppport tank closure decisions. The Hanford STCG includes representation from stakeholders, Tribal Nations, regulators, and Hanford Advisory Board members. Discussions with the STCG indicate a desire to actively participate in HTI's risk assessment and development of tank retrieval performance objectives that will provide data for future closure decisions.

A.1.1.6 Hanford Site Costs and Schedule

The life-cycle system cost for TWRS is estimated to be over $37 billion in constant 1996 dollars. However, the privatization contractor will largely drive these costs. The privatization contractor will be paid an agreed-upon fee per unit of waste produced that meets DOE specifications. This cost information will not be available until the final privatization contract award in 2005. Estimated costs for major projects and associated completion dates are shown in Tables A.2 and A.3.

Table A.2. Hanford Site System Costs[a]

Needs Breakdown Structure	Waste Activity Management	Estimated Cost ($M)[a]
Manage Tank Waste	Tank Farm Operations	8,860
	Waste Characterization[b]	710
	Waste Tank Safety[b]	370
Process Waste	SST Retrieval	2,350
	DST Retrieval	2,390
	Sludge Wash	210
	Cesium Removal	1,010
	LLW Vitrification[c]	3,050
	HLW Vitrification	3,060
System Closure	LAW Disposal[c]	300
	HLW Transportation	30
	HLW Disposal	5,680
	Closure	150
Total		28,170

(a) Constant 1997 dollars (DOE-RL and Ecology 1996a) (escalated at 3% per year to 1997 dollars)
(b) Supplementary cost from onsite activity data sheet information
(c) Costs are not based on privatization. Phase 1 Privatization will pretreat and vtirify 6% to 13% of the waste at a cost of about $5.5 billion.

Table A.3. Hanford Site Major Milestones[a]

Milestone Title	Completion Date
Mitigate/resolve tank safety issues	2001
Complete tank waste characterization	1999
Complete single-shell tank interim stabilization	2000
Complete tank farm upgrades	2010
Complete closure of single-shell tank farms • Retrieve waste from all single-shell tanks	2024 2018
Privatize operation of Tank Waste Remediation System pretreatment and immobilization facilities • Complete phase I pilot-scale testing • Award contract for phase II completion	 2004 2005
Complete vitrification of Hanford Site tank waste	2028
Complete closure of all double-shell tanks	2032
(a) Source: DOE 1996a.	

A.1.2 Idaho National Engineering and Environmental Laboratory

In 1949, the Atomic Energy Commission established the National Reactor Testing Station at INEEL, and 52 test reactors were constructed and tested. In the mid-1950s, the Site began receiving and storing wastes from other sites. Most of the reactors were phased out after testing, and only the Advanced Test Reactor is currently operating. One of the major facilities at the site, the Idaho Chemical Processing Plant, was used to reprocess spent nuclear fuel from reactor operations. Since April 1992, INEEL no longer reprocesses fuel, but the site still receives and stores spent fuel from research reactors and naval submarine reactors. This activity will be ongoing for the next 40 years. Facility decontamination and decommissioning is underway, resulting in ongoing production of liquid waste.

INEEL consists of nine major facility areas: Test Area North, Test Reactor Area, Idaho Chemical Processing Plant, Power Burst Facility, Experimental Breeder Reactor-1, Radioactive Waste Management Complex, Naval Reactors Facility, Central Facility Area, and Argonne National Laboratory-West. All the HLW from spent fuel reprocessing is confined to the Idaho Chemical Processing Plant (see Figure A.3).

INEEL is briefly described as follows.

- INEEL is located in southeastern Idaho; the site covers 2,310 km^2 (890 mi^2).

- The land surrounding the site is semiarid and used for recreation, grazing, and wildlife management.

- The Little Lost River, Big Lost River, Birch Creek, and Mud Lake are within a 32-km (20-mi) radius. Localized flooding of these streams can occur when frozen and melting snow combines with heavy spring rains.

- INEEL overlies the Snake River Aquifer, which is the largest aquifer in Idaho. Depth to the aquifer from the site varies from 61 m (200 ft) in the north to over 274 m (900 ft) in the south.

- INEEL is subject to prevailing westerly winds, although the mountain ranges bordering the site channel these winds to the southwest. Some small towns are located in the direction of prevailing winds.

- The average wind speed is 3.4 m/s (7.5 mi/h). Average annual precipitation is 22 cm (8.7 in.).

- The population within 80 km (50 mi) is 250,000 (DOE-ID 1995b, App. B).

A.1.2.1 INEEL Tanks and Calcine Bins

The HLW at INEEL is stored in stainless steel tanks (acidic liquids) and stainless steel calcine bins (solids). The 11 tanks at INEEL each have a capacity of 1.1 million L (300,000 gal). The tanks are all similar in design and are constructed of stainless steel contained in underground concrete vaults. The tank vaults are of three different types: two monolithic octagon vaults, four square vaults, and five octagonal pillar and panel vaults. There are no liners in any of the vaults. The five pillar and panel tanks must be removed from service by March 31, 2009. All remaining tanks must be removed from service by 2012.

From 1963 until shutdown in 1981, liquid HLW was evaporated and oxidized in a high temperature fluidized bed in the waste calcining facility. The calcined solids were then pneumatically transferred through underground pipelines to bin sets in the Calcine Solids Storage Facility. Newly generated waste is calcined in the New Waste Calciner Facility: waste from the tanks is also being calcined to free tank space and allow tanks to be removed from service. Operating the New Waste Calciner Facility produces about 660,000 L (175,000 gal) of recycled liquids to the tank farm after each calciner campaign. It is unlikely that operating the calciner will empty the tanks before 2012 without some major improvement in the flowsheet or constructing 3,785 m^3 (1 million gal) process surge tanks to support continued operations.

There are seven calcine solids storage facilities, including one newly constructed facility. The HLW calcine from these facilities must be retrieved and vitrified. Calcine is stored in stainless steel bin sets enclosed in massive underground concrete vaults with walls up to

1.2 m (4 ft) thick. Five of the seven storage facilities are full, and the sixth is partially full (Palmer et al. 1994).

There are six 1500- to 190,000-L (400- to 50,000-gal) V-tanks at INEEL. They are located 7 to 15 ft below grade and contain approximately 8,000-gal of sludge which is contaminated with PCBs. The V-tanks were primarily used as evaporator service tanks. A feasibility study for CERCLA remediation of these tanks is underway, and a ROD is expected in the fall of 1998.

A.1.2.2 INEEL Wastes

The 11 stainless steel tanks at INEEL store approximately 7.4 million L (2.0 million gal) of liquid HLW containing 2 MCi. The radioactive contents of the waste is summarized in Table A.1 (DOE 1996b). Of this liquid HLW, about 1.3 million L (300,000 gal) is HLW stored in the square vault tank (WM-189). The rest of the waste is sodium-bearing liquid waste stored in the other tanks. Site activities over the next 5 years will generate about 2.4 million L (640,000 gal) of liquid HLW and 2 million L (540,000 gal) of calcined solids (DOE-ID 1995a).

No HLW from reprocessing activities has been added to the tanks since 1992. However, about 20,000 L (5,000 gal) of sodium-bearing waste is being added to the tanks per month from facility decontamination and decommissioning, offgas system operation, and spent nuclear fuel storage. Most newly generated liquid wastes are initially treated by the Process Equipment Waste Evaporator. The concentrated liquid wastes are then sent to the tanks.

Approximately 3.8 million L (1 million gal) of calcined solid waste containing about 47 MCi is stored in vaults (DOE 1996b). More than 90% of the total radioactivity is in the calcine.

A.1.2.3 INEEL Regulatory or Programmatic Drivers

The regulatory drivers for remediating tank wastes and calcine are as follows:

- Settlement Agreement between the Governor of Idaho, DOE, and the Department of the Navy (Public Service Co. of Colorado v. Batt). The Governor of Idaho, DOE, and the Department of the Navy (Navy) reached an agreement settling the State's lawsuit (Public Service Co. of Colorado v. Batt) in October 1995. This agreement accelerates the schedules at INEEL as follows:

  - The State of Idaho will allow a total of 1,135 shipments of spent fuel to come to the INEEL for interim storage over a 40 yr period . The shipment allotments include 575 naval shipments, and the remaining shipments from DOE sites, foreign research reactors, university reactors and small shipments from private companies conducting DOE research.

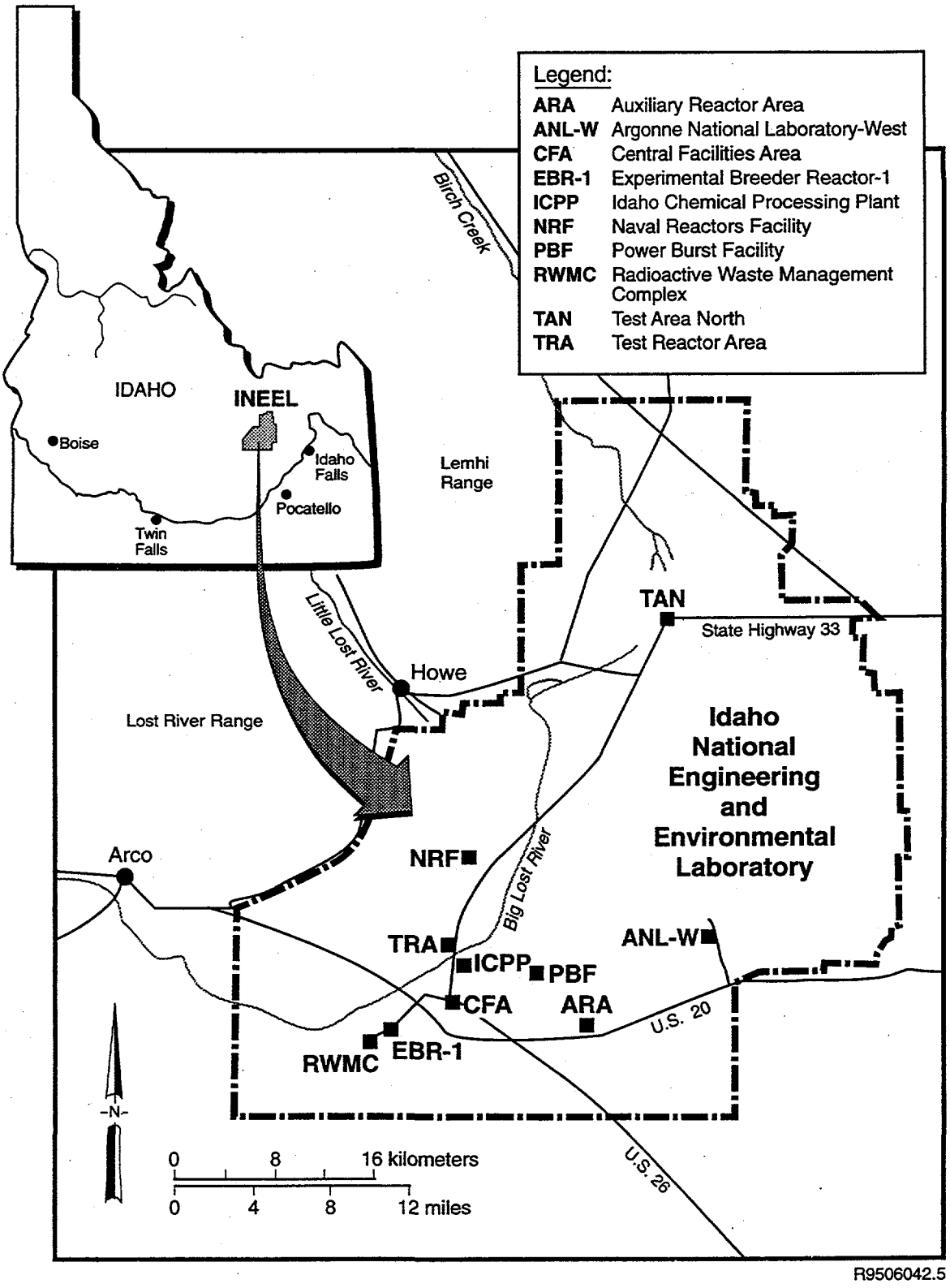


Figure A.3. Idaho National Engineering and Environmental Laboratory and Major Facilities

- Commence operation of the HLW evaporator by October 31, 1996, and operate the evaporator enough to reduce the tank farm liquid waste volume by no fewer than 1,250,000 L (330,000 gal) by December 31, 1997.

- The State of Idaho will allow a total of 1,135 shipments of spent fuel to come to the INEEL for interim storage over a 40-year period . The shipment allotments include 575 naval shipments, and the remaining shipments from DOE sites, foreign research reactors, university reactors and small shipments from private companies conducting DOE research.

- Treat all transuranic and alpha-bearing mixed waste now stored at the INEEL and begin shipments to WIPP by 1999. All transuranic waste will be removed from the State of Idaho by a target date of December 31, 2015 and now later than December 31, 2018.

- Complete the process of calcining all remaining nonsodium-bearing liquid currently at INEEL by June 30, 1998.

- Start calcination of sodium-bearing liquid waste by June 1, 2001, and complete calcination of sodium-bearing liquid waste by December 31, 2012.

- All spent fuel will be placed in Dry Storage by December 31, 2023.

- Remove all spent fuel from Idaho no later than 2035.

- Issue a record of decision to begin treatment of calcined waste by December 31, 2009, and complete treatment of all calcined waste by December 31, 2035.

- Final Site Treatment Plan (DOE-ID 1995a). This plan defines the schedule of commitments for processing radioactive liquid and calcine wastes for disposal. The plan is consistent with the new settlement agreement.

- INEEL site-wide EIS record of decision, June 1995. A record of decision was issued to treat sodium-bearing liquid waste using radionuclide separation processes in the Idaho Chemical Processing Plant tank farm and to vitrify the calcine from New Waste Calciner Facility. An additional EIS will be completed in 1999 that selects the final remediation strategy for HLW.

- Idaho Federal Facility Agreement and Consent Order, December 1991. This is an agreement between the U.S. Environmental Protection Agency, the DOE, and the Idaho Department of Health and Welfare. This agreement establishes procedures for addressing releases of hazardous substances.

- Notice of Noncompliance Consent Order, April 1992. This order states that the pillar and panel tanks must be removed from service by March 31, 2009. All remaining tanks must be removed from service by June 30, 2015.

- Modified Notice of Noncompliance Consent Order, March 1994. This order issued by the U.S. Environmental Protection Agency calls for construction of new tanks if they are determined to be needed in the record of decision for the EIS. The tanks would be considered Resource Conservation and Recovery Act-contained storage. The Modified Notice of Noncompliance Consent Order states that all nonsodium HLW in the tanks and as much sodium-bearing liquid as practical must be calcined by January 1, 1998. Sodium pretreatment processing technology and calcine immobilization technology must be selected by June 1, 1995. All tanks must be taken out service by June 30, 2015.

- Idaho Accelerated Cleanup Plan. (DOE-ID 1997). The plan describes how EM program in Idaho will meet Settlement Agreement requirements, maximize risk reduction and complete the EM mission at the lowest possible life-cycle costs. Idaho must have all HLW road-ready to be shipped out of Idaho by 2035.

A.1.2.4 INEEL Remediation System Description

The Idaho Chemical Processing Plant Proposed Waste Management Strategy is illustrated in Figure A.2. At INEEL, all waste streams managed under Environmental Management will be integrated, treated, and prepared for shipment. This means that the Remote Handled Immobilization Facility will treat TRU and HLW. A privatized approach will be used to design and construct the plants to treat the calcine and any remaining liquid waste to a disposable form. A new remote-handled immobilization facility will convert both liquid and calcine to a final waste form. Waste treatment activities are briefly described as follows:

- The New Waste Calciner Facility will continue to operate until approximately 2012. During this time, it will treat sufficient waste to meet the consent order requirements.

- New tanks will be brought on-line by 2012, if necessary, to provide the necessary surge capacity for continued Idaho Chemical Processing Plant operations after the last of the old tanks are taken out of service.

- The Remote Handled Immobilization Facility will be brought on-line in 2017, and remote-handled TRU will be processed from 2017 to 2019.

- After 2019, separation and vitrification of the HLW, stored calcine, and any residual or future liquid wastes will occur in the Remote Handled Immoblization Facility and continue until 2035.

- Radioactive liquids stored in the tank farms and dissolved calcine will be processed via TRU extraction, strontium extraction, and ion exchange at the Remote Handled

Immobilization Facility, and the concentrated HLW will be sent to the vitrification plant. Mercury will be removed from the HLW feed stream before vitrification.

- Liquid LLW will be collected from the ion-exchange column, concentrated in the LLW denitrator, and treated to remove mercury. The concentrated slurry from the LLW denitrator will be mixed with grout, poured into steel drums, and transferred to the LLW Interim Storage Facility (DOE-ID 1994).

"An alternative HLW process plan is being considered to reduce costs. Waste would be collected and stored in the tanks rather than be calcined after 2001. The RHIF would operate in two phases beginning in 2010. Phase I would consist of operating a separations/grouting facility to empty the tank farms by 2012. Phase II would consist of calcine dissolution and vitrification beginning in 2015. Twenty years (rather than 15) would be required for calcine treatment." (See letter to T. L. Wichmann from W. B. Palmer dated April 25, 1996.) The RHIF mentioned in the quote is the Remote Handled Immobilization Facility.

A.1.2.5 INEEL System Closure

The INEEL closure strategy has not been finalized. It must address the HLW tank farm residuals and final disposal of the LLW grout. The HLW will be vitrified and sent to a Federal geologic repository.

About 8 cm (3 in.) of a liquid heel that may contain sludge will remain on the bottom of the tanks after retrieval. The removal of this sludge is part of the Resource Conservation and Recovery Act closure activities that start in about 2009.[a] After removal of the heels, INEEL tanks will be closed as Resource Conservation and Recovery Act treatment, storage, and/or disposal units. A strategy is currently being evaluated that stabilizes some tanks containing sodium-bearing liquid waste by grouting them in-place.

After mixing the LLW with a cement-based mixture, the LLW grout will be placed in waste drums and stored. At closure, the drums will be transferred to a landfill for final onsite disposal as Class A LLW.

A.1.2.6 INEEL Costs and Schedule

The total system cost for remediation of HLW at INEEL is estimated to be about $5.7 billion in constant 1997 dollars. The distribution of costs and the associated schedule are shown in Tables A.4 and A.5.

(a) 1995 presentation. Tanks Focus Area High-Level Waste Tank Review Group.

Table A.4. Idaho National Engineering and Environmental Laboratory System Costs[a,b]

Needs Breakdown Structure	Waste Management Activity	Estimated Cost ($M)[c]
Process Waste	HLW Treatment Feasibility, EIS, and Technology	1,120
	HLW Pretreatment	951
	HLW Immobilization Facility	1,694
	HLW Treatment	1,525
	Vitrified HLW Storage	22
	LAW Treatment	165
System Closure	HLW Disposal	242
	LLW Disposal	23
Total		5,742

(a) Source: DOE-ID 1997.
(b) Includes costs for treating the low-activity portion of the waste.
(c) Constant 1997 dollars.

Table A.5. Idaho National Engineering and Environmental Laboratory Major Milestones[a]

Milestone Title	Completion Date
Restart New Waste Calciner Facility operation	1997
Startup New Waste Calciner Facility for processing sodium-bearing radioactive liquid waste	2001
Cease operation of the New Waste Calciner Facility	2012
Cease use of pillar and panel tanks	2009
Cease use of all tanks without secondary containment	2012
Begin operation of treatment facilities for high-level waste calcine	2019
Complete treatment of all high-level waste so that it can be shipped offsite	2035

(a) Source: Gurley, R., Director High-Level Waste Management, Lockheed Idaho Technologies Company, February 8, 1996. "TFA Request for High Priority TD Schedules and Dates-RNG-22-96." Letter to R. Quinn, Technical Manager Tanks Focus Area, Pacific Northwest National Laboratory.

A.1.3 Oak Ridge Reservation Overview

Weapons research facilities were established at the Oak Ridge Reservation in 1943. The Oak Ridge Reservation was the pilot-plant site for the reactors and separators processes that were later deployed at Hanford and SRS during the Manhattan Project. The site's role as a developer of uranium enrichment processes for production of nuclear weapons has decreased, but the production of nuclear isotopes for research purposes continues. The site consists of three major facility areas: the Y-12 Plant, Oak Ridge National Laboratory, and the K-25 Site (see Figure A.4). Waste tanks covered under the Tanks Focus Area are located at Oak Ridge National Laboratory in the Melton Valley and Bethel Valley areas.

The Oak Ridge Reservation is briefly described as follows.

- Oak Ridge Reservation is located on 140 km^2 (54 mi^2) within the corporate city limits of Oak Ridge, Tennessee.

- Facilities occupy about 701 ha (about 1,754 acre) or about 20% of the Oak Ridge Reservation. The remaining 2,806 ha (7,017 acre), or 80% of the site, is predominantly forested buffer zone.

- Land surrounding the nonarid site is predominately rural woodlands and used largely for residences, small farms, forest land, and pasture land.

- There are three lakes - the Watts Bar Lake, Melton Hill Lake, and Loudon Lake - and two rivers - the Clinch River and Tennessee River - within a 32-km (20-mi) radius.

- The DOE/Johnson Controls water treatment facility, which provides water to the city of Oak Ridge, is located just north of the Y-12 Plant.

- The Knox aquifer is the major aquifer in the Oak Ridge area.

- In Bethel Valley, depth to water table ranges from 0.30 to 10.7 m (1 to 35 ft), while in Melton Valley the range is from 0.30 to 20.4 m (1 to 67 ft).

- The average wind speed is 2.1 m/s (4.7 mi/h). The peak wind direction is from the west-southwest, with a secondary peak from the northeast. There are no towns or cities aligned with prevailing winds.

- Average annual precipitation is 130.9 cm (51.5 in.) (Turner 1993; DOE-ID 1995b, App. F).

- The population within 80-km (50-mi) radius is 880,000.

A.1.3.1 Oak Ridge Reservation Tanks

There are two types of tanks at Oak Ridge: legacy tanks and active tanks. These tanks are buried underground and vary in design and age. The 21 inactive tanks store legacy wastes. Legacy tanks containing dilute LLW supernatants and associated sludges include the 16 gunite and associated tanks and the 5 old hydrofracture tanks. The gunite and associated tanks consist of 12 (primarily 640,000-L [170,000-gal]) concrete tanks and six 7,500- to 15,000-L (2,000- to 4,000-gal) stainless steel tanks in the Bethel Valley Area. Twelve of the gunite and associated tanks have been identified as either leakers or tanks that receive in-leakage of surface water or groundwater. The site is actively involved in remediation of the Bethel Valley Evaporator Service Tanks (BVEST) and gunite and associated tanks. The current plan is to complete the remedial action by 2010. The old hydrofracture tanks consist of five 50,000- to 95,000-L (13,000- to 25,000-gal) carbon steel tanks. The hydrofracture tanks are located in the Melton Valley Area.

Active tanks store waste from an extensive underground collection, transfer, and storage system that interconnects generator buildings, tanks, and processing facilities. The wastes from the active underground collection system are sent to 13 active 190,000-L (50,000-gal) stainless steel central treatment/storage tanks. Five tanks are evaporator service tanks, and eight are Melton Valley Storage Tanks located approximately 1.6 km (1 mi) from the evaporator area. Liquid LLW concentrate has been stored in the Melton Valley Storage Tanks since 1984, and storage space is now very limited (Turner 1993). Six new Melton Valley Storage Tanks are under construction.

A.1.3.2 Oak Ridge Reservation Wastes

There are approximately 2.45 million L (648,000 gal) of supernate and 670,000 L (177,000 gal) of sludge storage in Oak Ridge tanks as shown in Table A.6.

	Supernate			Sludge		
Tank Farm	**Volume (L)**	**Volume (gal)**	**Ci Content**	**Volume (L)**	**Volume (gal)**	**Ci Content**
MVST	776,000	205,000	22,500	386,000	102,000	135,000
BVEST	235,000	62,000	4,000	76,000	20,000	8,000
GAAT	1,306,000	345,000	4,000	185,000	49,000	14,000
OHF	136,000	36,000	800	23,000	6,000	28,500
Totals	2,453,000	648,000	31,300	670,000	177,000	185,500

Table A.6. Oak Ridge Reservation Wastes

The waste contains approximatley 216,800 Ci (primarily cesium-137, strontium-90, and other fission products). The wastes also contain high concentrations of sodium nitrate. Tank waste is continually being generated by ongoing research and development at the Oak Ridge Reservation. There is approximately 1.5 million L/year (400,000 gal/year) of waste being generated, which is reduced through evaporation to approximately 75,000 L (20,000 gal) of waste concentrate.

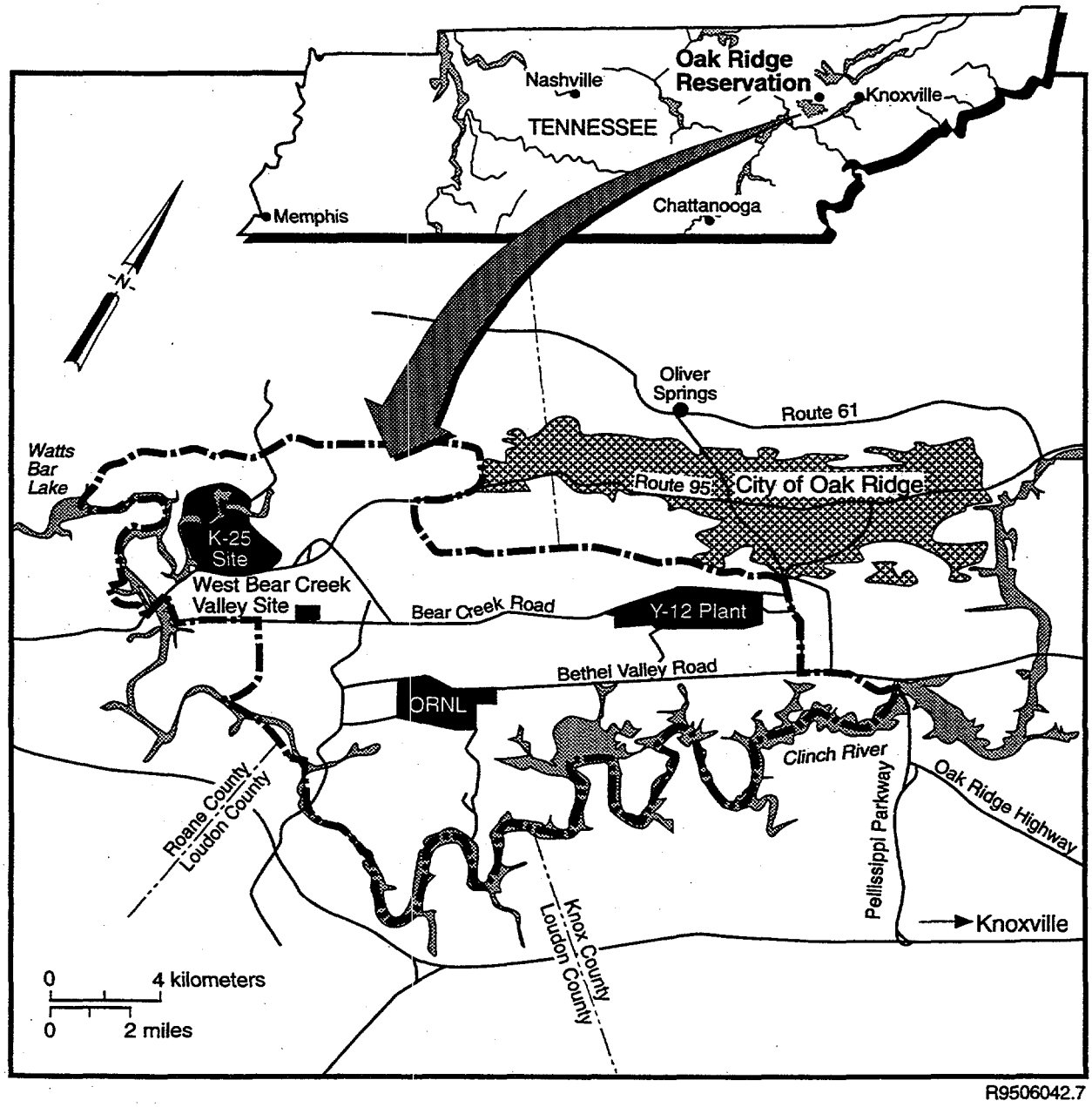


Figure A.4. Oak Ridge Reservation and Major Facilities

A.1.3.3 Oak Ridge Reservation Regulatory or Programmatic Drivers

The regulatory drivers for remediating tank wastes are as follows:

- ORNL Federal Facility Agreement (DOE-OR et al. 1992). This is an interagency agreement between the U.S. Environmental Protection Agency, the DOE, and the Tennessee Department of Environment and Conservation, which was implemented on January 1, 1992. This agreement establishes requirements under CERCLA for the management of tanks. Per this agreement, DOE must remove all tanks from service that operate without secondary containment. Tanks with secondary containment may continue to operate (Turner 1993).

- Tennessee Department of Environment and Conservation (TDEC) Commissioner's Order for the Oak Ridge Reservation (ORR) Site Treatment Plan (STP). This requires that RCRA LDR waste must be treated for disposal per the agreed upon schedule.

- Oak Ridge Accelerated Cleanup Plan. (DOE OR 1997a). The plan accelerates cleanup of the site by 50 years. The high funding case will treat and disposition all TRU legacy waste by 2006 (2010 in the low funding case). Privatization will be an integral part of achieving clean up goals.

- Environmental Management Contract (RFP No. DE-RP05-970R22700). The DOE Oak Ridge Operations Office is awarding a performance-based contract to carry out the Accelerated Cleanup Plan. The plan accelerates cleanup so that all tank waste will be treated and disposed by 2006.

- Removal, Treatment, Disposal Certification, Transportation, and Disposal of TRU/Alpha LLW at ORNL. RFP DE-RP0598OR22516 (DOE-ORb 1997). The waste to be treated includes 750 cubic meters of RH TRU and 1,600 cubic meters of supernate stored in below-grade Melton Valley Storage Tanks.

A.1.3.4 Oak Ridge Reservation Remediation System Description

Inactive tanks at Oak Ridge are managed by the Oak Ridge National Laboratory Remedial Action Program. The tanks considered to pose the greatest risk are the gunite and associated tanks. The CERCLA treatability studies are planned for tank heel characterization of these tanks using the Light-Duty Utility Arm. The CERCLA treatability studies will demonstrate sluicing technologies for waste removal, including conventional sluicing with a nozzle, the Light-Duty Utility Arm, and mixer pumps. The remaining inactive tanks have been tentatively scheduled for remediation based on site investigation results (Baxter et al. 1995). Lessons learned from the gunite and associated tanks studies will be used to develop remediation strategies for these tanks.

For the active tanks, the plan is to privatize removal and treatment of the supernates and sludges. A request for proposal (RFP) was issued for treatment and disposal of

transuranic/alpha low-level waste presently stored at the Oak Ridge National Laboratory (ORNL). The major contaminants of concern in the Melton Valley Storage Tanks supernates are strontium-90, cesium-137, technetium-99, and ruthenium-106. Nitrates must also be destroyed or removed before the treated waste can be discharged into the environment (ORNL 1994). The waste management strategy for the Melton Valley Storage Tanks is illustrated in Figure A.2. The highlights of the plan are as follows.

- Evaporate the liquid, remove the cesium, and solidify the Melton Valley Storage Tank supernatant in grout for disposal at the Nevada Test Site.
- Dispose of treated sludges at the Waste Isolation Pilot Plant.
- Develop separations and immobilization technologies to allow future onsite disposal of newly generated liquid LLW.
- Deploy source reduction to obtain less than 15% of current volumes of newly generated waste.

A.1.3.5 Oak Ridge Reservation System Closure

As stated in the Oak Ridge National Laboratory Federal Facility Agreement, DOE must remove or decontaminate all residues, structures, soils, and equipment associated with tank systems that have been removed from service. The tanks will be closed according to CERCLA requirements for tanks. The CERCLA requires a risk-based, prescriptive strategy for establishing clean-up requirements.

Treated wastes will be shipped offsite for disposal. The two options for TRU waste disposal are to 1) treat the waste to meet WIPP waste acceptance criteria or 2) treat the waste to meet NTS waste acceptance criteria. The gunite tanks will be stabilized in situ after removing the sludge. One scouring pass of the walls will be performed after sludge removal. The Old Hydrofracture tanks will be emptied and left in place (DOE-OR 1997a).

A.1.3.6 Oak Ridge Reservation Costs and Schedule

The total system cost for remediating tank waste at Oak Ridge is estimated to be about $1.1 billion in constant 1997 dollars. Available information on costs and schedule is provided in Tables A.7 and A.8. Disposal options for tank wastes are now being investigated; thus, they are not included in the costs.

Table A.7. Oak Ridge Reservation System Costs

Needs Breakdown Structure	Waste Management Activity	Estimated Cost ($M)
Process Waste	TRU Waste Treatment (OR-38108)	240
	Bethel Valley Remedial Action (OR-43203)	200
	White Oak Creek Remedial Action (OR-43201)	200
Total		640

(a) Source: DOE-OR 1997a (Accelerated Cleanup Plan)
(b) Constant 1997 dollars

Table A.8. Oak Ridge Reservation Major Milestones

Milestone Title	Completion Date (a, b)
Complete Bethel Valley Remedial Action	2006
Complete White Oak Creek Remedial Action	2006
Complete legacy transuranic (TRU) waste treatment	2006
Complete legacy mixed and low-level waste treatment	2006

(a) Source: DOE-OR 1997a (Accelerated Cleanup Plan)
(b) The White Oak Creek Watershed includes the inactive Old Hydrofracture Tanks. The Bethel Valley Watershed includes the gunite tanks. TRU waste treatment includes sludges from the MVST and BVEST.

A.1.4 Savannah River Site Overview

When the site was established in the early 1950s, the primary mission was to produce special nuclear materials to support U.S. defense (tritium and plutonium-239), medical programs, and space (plutonium-238. The production reactors and fuel assembly areas are no longer operational, but the spent nuclear fuel reprocessing facilities operate as required to supply uranium to the National Aeronautics and Space Administration. The site's present mission is to manage system wastes.

The site is divided into several major facility areas including Area C5 for mixed waste storage; Area B for industrial waste disposal; Area E for waste storage, preparation, and disposal; Area Z for saltstone processing and disposal, and Area S for defense waste processing. The two tank farms are located in the F Area and the H Area (see Figure A.5).

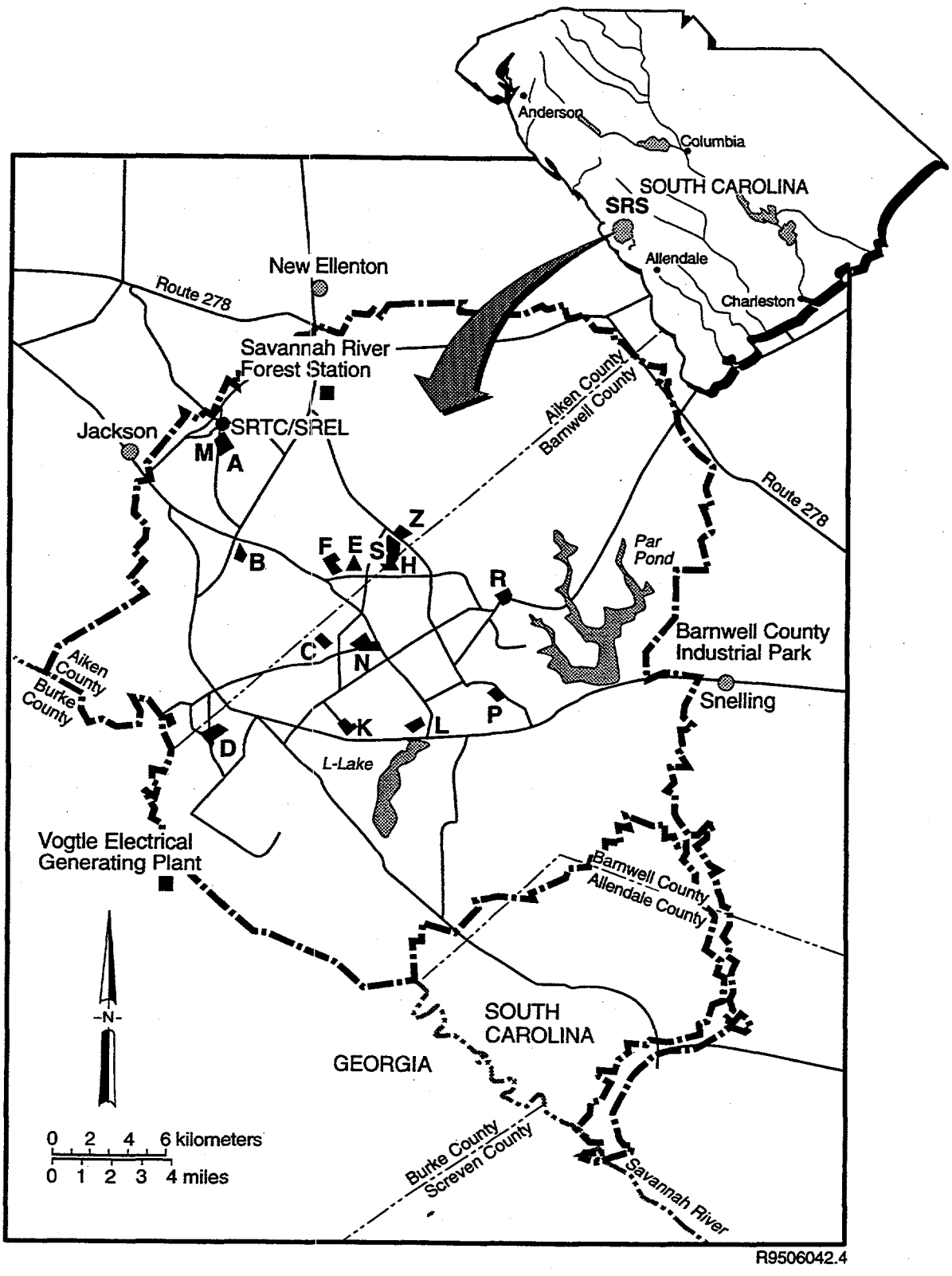


Figure A.5. Savannah River Site and Major Facilities

The SRS is briefly described as follows.

- The SRS is located on 840 km^2 (325 mi^2) in western South Carolina. Land surrounding the site is predominately rural woodlands used largely for residences, small farms, forest land, and pasture land.

- F and H Areas (where tank farms are located) are in an area of shallow groundwater that flows toward the Upper Three Runs and Four-Mile Branch tributaries to the Savannah River.

- Currently, there is little impact to the water quality of the Savannah River and its tributaries from SRS activities, except for a slight increase in tritium concentration.

- Prevailing winds in the area are from the northeast and the west-southwest.

- The average wind speed from 1987 through 1991 was 3.8 m/s (8.5 mi/h). Atmospheric conditions favor dispersion of air pollutants approximately 79% of the time.

- • Average annual precipitation is 122 cm (48 in.).

- The population within an 80-km (50-mi) radius of the site is approximately 620,000 (DOE-SRS 1995; DOE-ID 1995b, App. C).

A.1.4.1 SRS Tanks

There are 51 underground storage tanks at SRS, built in four different types (I, II, III, and IV) (see Table A.9). The tanks contain 126.3 million L (33.4 million gal) of liquid HLW. These tanks are located in the F and H Area Tank Farms. Under the Federal Facility Compliance Agreement executed by DOE, the U.S. Environmental Protection Agency, and the South Carolina Department of Health and Environmental Control in 1993, all the Type I, II, and IV tanks (24 tanks) are being retired because they do not have full secondary containment. Four tanks have leaked to the secondary containment pan, with one tank (Tank 16) having overflowed the secondary and leaked to the environment, and two tanks have had minor water incursions. Tank 20 had cracks at approximately the liquid level, however this tank was closed in 1997. It showed no signs of leaked waste.

Type III tanks are still receiving waste from the limited production activities underway at SRS. Two types of waste are being sent to the tank farms: 1) high-heat waste, which contains most of the radionuclides and must be aged in a high-heat waste tank before evaporation, and 2) low-heat waste. Incoming waste is treated to prevent corrosion of the tank walls. Seven of the 27 Type III tanks are used for purposes other than waste storage; three tanks are used for in-tank precipitation, three are used for extended sludge processing, and one is used as the feed tank for the saltstone manufacturing facility.

Table A.9. Savannah River Site Tanks[a]

Type	Capacity Liters (gal)	No. of Tanks	Description	Total Curies (%)
I	2,800,000 (750,000)	12	Steel cylinder in concrete with secondary steel pan at partial height and cooling capacity	27
II	4,000,000 (1,030,000)	4	Same as Type I tanks	8
III	4,900,000 (1,300,000)	27	Secondary steel pan at full height and cooling capacity	64
IV	4,900,000 1,300,000	8	Uncooled, single wall	<1
(a) Source: DOE SRS 1996, Appendix B.				

The waste management program at SRS is currently installing mixing and transfer pumps on 50 of the HLW tanks to allow retrieval and transfer of waste for processing. Many tanks are being upgraded with air-monitoring equipment to correct deficiencies and bring the tanks into compliance.

A.1.4.2 SRS Wastes

As of December 1995, tank waste consisted of 58.1 million L (15.3 million gal) of liquids containing 231.4 MCi and 68.2 million L (18 million gal) of solids containing 467 MCi (DOE 1996b). Liquid is the total of free liquid and interstitial liquid in the salt and sludge. Solid is the total salt, sludge, and precipitate in the waste tanks (DOE 1995b). Chemical constituents in the supernate are primarily sodium nitrate (49 wt%), sodium nitrite (12 wt%), sodium hydroxide (13 wt%), aluminum tetrahydroxide sodium salt (11 wt%), sodium sulfate (6 wt%), and sodium carbonate (5 wt%). The chemical composition of the sludge consists primarily of aluminum oxide (33 wt%), iron oxide (30 wt%), and sodium salts (6 wt%). Although the waste is classified as high level, about 93% of the volume is low-level salt solution (DOE-SRS 1994). The radionuclide content of the waste is summarized in Table A.1. The Type III tanks hold 64% of the radioactivity in the tanks.

SRS currently generates small amounts of HLW as a result of limited production activities. After its introduction into the tanks, the HLW settles, separating into a sludge layer at the bottom of the tank and an upper layer of salts dissolved in water (supernate).

SRS emphasizes volume reduction to manage the newly generated liquid wastes. Volume reduction is performed using evaporation with some ion exchange for dilute waste streams. There are four evaporators (two at each tank farm), but most volume reduction takes place in

the 2H Evaporator. Evaporation of the supernate in the tank farms using evaporators results in a third waste form in the tanks, crystallized saltcake.

Approximately 22 million L (5.8 million gal) of HLW will be received in the tank farms as a result of Defense Waste Processing Facility operation. After the facility begins operation, the 2F and 2H Evaporators will not process waste fast enough to keep pace with the facility, so construction of a new evaporator is planned. It is about twice the size of existing evaporators with a 30-year versus a 10-year tube design life. The current startup date for the replacement HLW evaporator is September 1998. (DOE-SRS 1995).

A.1.4.3 SRS Regulatory or Programmatic Drivers

The regulatory drivers for remediating tank wastes at SRS are as follows:

- Defense Waste Processing Facility EIS (DOE-SRS 1982) and Supplemental EIS (DOE SRS 1994). The record of decision from the EIS (47 FR 23801) documents the decision to construct and operate the Defense Waste Processing Facility. Since then, DOE has prepared a supplementary EIS that addresses in-tank precipitation, saltstone processing and disposal, a late wash facility addition, and a number of other modifications to the Defense Waste Processing Facility. The record of decision (60 FR 18589) was issued in April 1995 to complete startup testing and begin operation of the Defense Waste Processing Facility.

- Savannah River Federal Facility Agreement (EPA 1993). This is an agreement between the U.S. Environmental Protection Agency Region IV, the DOE, and the South Carolina Department of Health and Environmental Control. This agreement establishes requirements for remediation of SRS. Tanks must meet structural integrity requirements or be removed from service.

- Savannah River Waste Management EIS (DOE-SRS 1995). This sitewide EIS provides the basis to select processes to manage wastes generated from ongoing operations and the operation of the Consolidated Incineration Facility. The record of decision from this EIS (60 FR 26845) documents the decision to construct and operate the HLW evaporator and to transfer waste from the storage tanks to the Defense Waste Processing Facility when it becomes operational.

- Site Treatment Plan (WSRC 1995). The Federal Facility Compliance Act requires a site treatment plan for treating and disposing of mixed wastes. The SRS Site Treatment Plan identifies the Defense Waste Processing Facility as the preferred treatment option for treating liquid HLW. The Defense Waste Processing Facility startup occurred in March 1996.

- SRS Accelerated Cleanup Plan (DOE-SRS 1997). The plan includes removal of waste from 14 of the 24 highest risk tanks and closure of the 14 tanks (these tanks store over

111 million curies of high level waste). At the end of 2006, over 37% of the HLW in tanks will be immobilized to a safe final form.

A.1.4.4 SRS Remediation System Description

The SRS remediation strategy is illustrated in Figure A.2. The HLW from the tanks will be treated in the HLW system. The HLW system includes the H Area pretreatment process facilities, H and F Tanks Farms, S Area vitrification, and Z Area saltstone process facilities. There are four processes to pretreat waste before vitrification: waste removal, extended sludge processing, in-tank precipitation, and late wash, as described below.

- During waste removal, salt and sludge are agitated in water using 7,600-L/min (2,000-gal/min) slurry pumps. A saturated supernate is produced and transferred to in-tank precipitation to remove radionuclides.

- Sludge from the HLW storage tanks is transferred to a tank at the extended sludge processing facility, mixed with caustic to dissolve excess aluminum, and washed. After gravity settling, the salt solution is evaporated and sent to waste storage on in-tank precipitation. The sludge becomes feed to the Defense Waste Processing Facility.

- During in-tank precipitation, dissolved salt from the waste removal process is treated with sodium titanate and sodium tetraphenylborate. The slurry is filtered in a sintered metal filter, and a concentrated precipitate is produced. The filtrate is stripped of benzene and converted to saltstone grout.

- Washed precipitate from in-tank precipitation is sent to late wash. During late wash, the nitrite added to mitigate corrosion of the storage tank and soluble organic degradation products are removed from the concentrated precipitate. The concentrated precipitate is then sent to the Defense Waste Processing Facility for conversion to glass.

The Defense Waste Processing Facility contains the vitrification processing equipment to vitrify the highly radioactive sludge and precipitate from in-tank precipitation into borosilicate glass. The Defense Waste Processing Facility startup occurred in April 1996. Waste vitrified in the facility is stored in a glass waste storage building for up to 10 years. No permanent disposal for HLW will be provided at the site. The HLW will be shipped offsite for permanent disposal (WSRC 1996).

The saltstone manufacturing plant and disposal vaults will be used to treat and dispose of the low radioactivity salt solution resulting from the in-tank precipitation process. The saltstone plant is in operation.

A.1.4.5 SRS System Closure

After removal from service, all wastes, tank structures, and underlying soils must be treated and decontaminated or removed from the site. The waste tanks will be closed as state-regulated wastewater treatment units.

Saltstone grout is pumped to aboveground concrete vaults and solidified. Once filled, the vaults are capped with weatherproof concrete. Final closure involves covering the vaults with a clay cap and backfilling with soil. Because the SRS is located near populated areas, the environmental restoration goal is to have all land and groundwater near the perimeter of the site permitted for unrestricted use (DOE 1995). This may impact closure requirements for tank farm areas.

On July 28, 1997, Tank 20 was officially declared closed, making it the first High Level Waste tank to be closed in the history of the Department of Energy. The tank and its internal equipment were filled with layers of varying grout material and all utilities and services were isolated from the tank such that no further surveillance of the tank, tank equipment, or ancillary services is required. SR's goal is to remove from service 20 of 24 HLW tanks by the year 2006 that do not satisfy the full secondary containment criteria.

A.1.4.6 SRS Costs and Schedule

The total system cost for SRS is estimated to be about $13 billion in unescalated constant 1996 dollars. The distribution of costs by waste management activity and the associated schedule are provided in Tables A.10 and A.11.

Table A.10. Savannah River Site System Costs[(a)]

Needs Breakdown Structure	Waste Management Activity	Estimated Cost ($M)
Manage Tank Wastes	F and H Area Tank Farm Operations	3,205
	Tank Farm Safety Projects	56
Process Waste	Vitrification	5,137
	Glass Waste Storage	355
	In-Tank Precipitation/ESP	2,777
	Effluent Treatment Facility	660
	High-Level Waste Removal	1,411
	Saltstone	670
Total		14,271
Source: DOE-SRS 1997		

Table A.11. Savannah River Site Major Milestones[a]

Milestone Title	Completion Date
Initiate DWPF Radioactive Operation	1996
Late Wash Ready for Radioactive Operations	1997
Start Operation of Consolidated Incineration Facility	1997
Complete Closure of Tank 20	1997
Complete Closure of Tank 17	TBD
Start-up In-Tank Precipitation Operations	1998
Initiate Replacement High Level Waste Evaporator	1999
Initiate Late Wash Radioactive Operations	2000
Initiate DWPF Coupled Operations	2000
Complete Closure of 20 Old Style Tanks	2006
Start Shipping Canisters to the Federal Repository	2015
Waste Removal Complete from all Tanks	2020
Complete Defense Waste Processing Facility Activities	2022
Complete Saltstone Vault High-Level Waste Activities	2024
Complete Shipping Canisters to the Federal Repository	2026
Complete High-Level Waste Management Activities	2026
(a) Source: WSRC 1997	

A.2 System Risks

The Tanks Focus Area seeks to develop a risk-based portfolio of technology development activities. Three types of system risks are of concern:

- technical risks - risks that jeopardize current technical baselines or technical performance requirements.

- programmatic risks - risks that jeopardize existing regulatory agreements and schedules, including advisory or stakeholder demands that are not formalized in current baseline plans but require site responses.

- environmental, safety, and health risks - risks to involved workers, noninvolved onsite workers, the public, or the environment. These risks result from direct exposure from contaminated air or groundwater.

A complete assessment of these three types of risk is not available. However, several important parameters for analyzing these risks are provided in Table A.12. Five types of parameters are provided:

- technical - This risk arises from functional uncertainties in site tank remediation baselines (e.g., most sites are uncertain about whether the feed to immobilization can be analyzed to determine if it meets requirements without causing bottlenecks in processing). This

risk is a function of the technical complexity of the baseline and the extent to which baseline technologies have been proven. The risk is estimated as probability of success.

- programmatic - This risk depends on the flexibility of the existing Federal Facility Compliance Agreement, the amount and radioactivity of the waste to be treated, and amount of time provided to reach the agreement's milestones. The risk is estimated in terms of cost or schedule variance.

- groundwater/public - The risk from groundwater contamination is primarily long term and to the public, because groundwater contamination does not occur for many years after the original spill or leak. Groundwater contamination is a function of the transport characteristics of the soil below the tanks, the depth to the water table, the amount of release, and the type of release. This risk is estimated as the number of incremental cancer fatalities.

- air/noninvolved onsite worker and public - The risk from atmospheric dispersion of radioactive and chemical contamination is near term and results from routine stack releases, disturbance of contaminated soils, and accidental releases. The risk is to noninvolved onsite workers and the public. This risk is a function of the amount of release, the type of release, and the amount of atmospheric dispersion. This risk is often estimated as the number of incremental cancer fatalities.

- involved worker - This is cancer risk due to occupational exposure to hazardous chemicals or radiation resulting from tank waste remediation activities to the involved worker. The involved worker is also subject to injury or death from an on-site accident (noncancer).

The risks drivers for these are briefly discussed for each of the Tanks Focus Area sites in the following sections.

A.2.1 Hanford Site Risks

Hanford is facing significant uncertainties due to the changes in site management, the technical complexity of the baseline, the volumes of radioactive materials involved, and the high cost of cleanup. These uncertainties are discussed in three major areas: technical, programmatic, and health and safety.

A.2.1.1 Hanford Site Technical Risks

Technical risks for the Hanford baseline are increased due to the number of unproven technologies required for the breadth and scale of the remediation (e.g., past-practice sluicing, removal processes for cesium and other radionuclides, large-scale melters to produce LLW glass). In addition, the baseline is dependent on the construction of a

geologic waste repository. There may not be a repository; however, if it is built, some of the waste will be treated before it is available. This necessitates interim storage of the waste.

Technical risk to DOE for those processes within the privatization scope may be reduced by the privatization strategy being implemented at Hanford. Under the proposed privatization strategy, private companies will accept much of the technical risk associated with treatment of the waste within the scope of these contracts. The methods for processing the wastes will not be restricted to vitrification. However, before employing a technology other than vitrification, the performing contractor must prove that the alternative technology meets or exceeds the performance standards applicable to vitrification. DOE efforts will be focused on defining and monitoring the requirements to be met by the selected contractor for the treated tank waste to be returned to DOE control after treatment. DOE continues to be responsible for safe operation of the tank farm, characterization of the waste, and site closure.

High-priority technology development needs identified by the Site Technology Coordination Group to reduce technical risk for the Hanford baseline include the following.

- Off-riser sampling technology and in situ measurement technology to gather data on waste energetics and moisture in single- and double-shell tanks.

- High pressure sluicing technology and alternative retrieval methods to improve the waste retrieval system performance for tanks.

- Real-time waste property measurement instrumentation to monitor waste transfers for leaks and line breaks, trapped gas, and line plugging.

- Technology for management and control of leakage during tank storage and retrieval operations and after disposal of the immobilized LLW in onsite vaults.

- Technically viable, practical approaches for removal of technetium, TRUs, strontium, and cesium from Hanford tank supernatants. Associated processes for immobilizing the solid wastes produced from these removal operations must also be demonstrated.

- Solid-liquid separation of fine solids and colloidal particles from Hanford supernatants to assure that the LLW stream will have acceptably low concentrations of insoluble radioactive material, principally strontium-90 and TRU radioisotopes.

- Small-scale testing of pretreatment processes, melters, process instrumentation, and offgas treatment systems to support the design of facilities by the private sector to treat Hanford LLW and HLW streams.

Table A.12. Summary of Risk Evaluation Parameters for Hanford Site, Idaho National Engineering and Environmental Laboratory, Oak Ridge Reservation, and Savannah River Site Tanks[a,b]

	Sites			
Risk Parameters	**Hanford**	**INEEL**	**Oak Ridge Reservation**	**Savannah River Site**
Groundwater/Public				
No. of tanks	149 single-shell 28 double-shell	11 tanks 7 calcine solids storage facility	34	51
Vol. of tank waste (million L/million gal)	208/55	7.2/1.9 liquid waste 3.8/1 calcined	1.86/0.49 legacy 1.5/0.4 active (per year)	126.3/33.4
Tanks known or assumed to have leaked	67	Not applicable	12	1
Total curies (Mci)	70.1 (liquid) 128.3 (solid)	2 in tanks 49.6 in calcine solids storage facility	0.13 legacy 0.034 active	231.4 (liquid) 302.3 (solid)
Vol. of leaks (L/gal)	3,800,000/1,000,000	Minimal	Minimal	75-113/20-30
Depth to water table (m/ft)	55-95/180-310	61-195/200-600	0.3 to 20.4/1 to 67	40/130
Annual precipitation (cm/in.)	16/6.3	22/8.7	130.9/51.5	122/48
Air/Noninvolved Worker and Public				
Safety concerns	Watch List	Potential for flammable gas generation heel	None	Hydrogen & benzene production
Average wind speed (m/s; mi/h)	3.6/7.9	3.4/7.5	2.1/4.7	3.8/8.5
Prevailing wind direction (wind blows from this direction)	WNW	W	WSW	NE
Nearby population (80-km radius)	370,000	250,000	880,000	620,000
Onsite population	11,000	8,000	16,000	20,000

Table A.12. (contd)

Risk Parameters	Sites			
	Hanford	INEEL	Oak Ridge Reservation	Savannah River Site
Groundwater/Public				
Involved Worker				
No. of proposed remediation workers (FTE)	1,000	Not available	Not available	Not available
Programmatic				
Cost ($ billion)	36.8	3.4	1.1	13.3
Schedule	2032	2035	2045	2028
Technical				
Status of technology	Unproven	Unproven	Unproven	Unproven
Scale of effort	Large	Medium	Small	Large

(a) Environmental information (DOE-ID 1995b, App. A, B, C, and F; Turner 1993).
(b) Cost and schedule information (DOE 1996a) and Site Representatives.

- Inspection and testing tools to verify conformance with waste acceptance specifications before DOE takes custody of the LLW and HLW products from the immobilization vendors.

- Criteria for closing tanks at a semiarid site, because this work is necessary to provide a technical basis for performance specifications for waste retrieval systems.

A.2.1.2 Hanford Site Programmatic Risks

This is a time of considerable programmatic risks at Hanford for a number of reasons:

- The DOE Richland Operations Office awarded the management and integration contract for the Hanford Site to Fluor Daniel Hanford, Inc. The contractor assumed contract responsibilities on October 1, 1996. The contract is performance-based and is intended to reduce costs and milestone slippage.

- A Hanford Federal Facility Agreement and Consent Order TWRS Privatization Change Package has been submitted, and the agencies involved are seeking public comment. The DOE plans for private financing and operation of the tank waste treatment facilities. The change will not affect major milestones (e.g., the consent order states that cleanup of the tanks must be completed by 2029) for the processing of tank waste, except that LLW will be treated by 2024 instead of 2028. The contract is performance-based and is intended to reduce costs and milestone slippage. However, some site studies indicate that pilot-scale treatment of actual tank waste, which is part of privatization, will not uncover operational problems and will actually increase cost and schedule risk (Gasper 1995).

- Defense Nuclear Facilities Safety Board Recommendation 93-5 (DOE-RL 1994) was not met. This recommendation required safety-related sampling and analysis to be completed on specified tanks by July 1995 and on other tanks by July 1996. The failure may result in downsizing the sampling campaigns at Hanford or delaying construction of TWRS facilities until characterization is complete.

A.2.1.3 Hanford Site Health and Safety Risks

The risks from tank waste remediation alternatives have been evaluated in the TWRS EIS (DOE-RL and Ecology 1996a). The relative distribution of environmental, safety, and health risks for the various tank waste remediation alternatives are shown in Table A.13. As shown, the no action alternative is not acceptable due to the danger of tank farm accidents and contaminants eventually leaking from the tanks and leaching to the groundwater. If an ex situ remediation alternative is selected, the most significant short-term environmental, safety, and health risks are from accidents as employees commute to work or transport waste to the repository. In situ disposal of waste minimizes worker and transportation risks, but in situ disposal results in high risk to the intruder over the short term and may have significant

accident risk if in situ vitrification is deployed. Ex situ treatment of tank waste has been selected as the preferred alternative because long-term risk to the public from migration of contaminants to the groundwater is the least.

Risks from migration of contaminants to the groundwater are being reevaluated due to finding cesium-137 much deeper in the vadose zone below the SX tank farm than anticipated. Recent recommendations from the Hanford Vadose Zone Expert Panel are prompting the site to drill additional boreholes to determine how contaminants are being transported (broad plume or vertical pathway). Information gathered from the vadose zone actions will be used to better estimate risks from tank waste remediation.

Table A.13. Risk Associated with Remediation of Hanford Site Waste Tanks[a]

	Source of Risk					
	Traffic Fatalities [b]		Increased Cancer Fatalities			
Alternative	Commute	Repository	Worker [c]	Worker	Public	Public
No action	25	0.00	<1 (3)	20[d]	2[d]	GW
In situ fill and cap	6	0.00	<1 (1)	20[d]	2[d]	I
In situ vitrification	13	0.00	<1 (2)	46[e]	5[e]	I
Ex situ intermediate separations	21	3 (13)	3 (2)	20[d]	2[d]	Low
Ex situ no separations	10	2 (19)	4 (2)	20[d]	2[d]	Low
Ex situ extensive separations	20	3 (8)	3 (2)	20[d]	2[d]	Low

(a) Source: DOE-RL and Ecology 1996a.
(b) Employees commuting to and from work and transporting waste to the high-level waste repository. Values in parenthesis are the additional deaths from cancer due to radiological exposure to the public from the unlikely event of a serious transportation accident on the trip to the repository.
(c) Increased number of fatal cancers in exposed worker population. Values in parenthesis are the deaths due to occupational accidents during construction and operation.
(d) Hydrogen burn in waste storage tank.
(e) Offgas duct rupture.
GW= The risk to the groundwater user is unacceptable.
I = The risk to the intruder is fatal.

A.2.2 Idaho National Engineering and Environmental Laboratory Risks

A regulatory agreement is now in place that drives the remediation strategy at INEEL. The recent settlement agreement between the Governor of Idaho, the Navy, and the DOE Idaho Operations Office requires that all waste be ready to be transported out of Idaho by 2035. It also accelerates treatment of calcined waste so that it can be more quickly put into a form for transport out of Idaho to a permanent geologic repository. Requirements to accelerate the schedule and reduce schedule risks for the INEEL baseline are discussed in the following sections.

A.2.2.1 INEEL Technical Risks

Because of the settlement agreement, INEEL has proposed a strategy to remove, process, and immobilize liquid HLW in the tank by calcining it. Modeling and simulation efforts have shown that without an improved calcination flowsheet for treating existing tank waste, achieving a cease use of the tank farms by 2012 will not occur. An alternative calcination flowsheet is viewed at this time as the only reasonable strategy to comply with the settlement agreement. Development of this flowsheet is identified as critical to meeting regulatory drivers.

Other high-priority technology development activities identified by INEEL to address technical risks for the site's remediation strategy include the following.

- End effectors and Light-Duty Utility Arm deployment systems are needed to support in situ tank waste characterization, nondestructive examination of tank walls, and heel retrieval or stabilization for the FY97 Idaho Chemical Processing Plant Tank Heel Removal Project.

- Technology is needed to remove undissolved solids from tank waste and dissolved calcine and to partition radionuclides (TRU, strontium, technetium, and cesium) from acidic liquid feeds (liquid waste and dissolved calcine).

- A grout process must be developed for the immobilization of the low-activity waste fraction of the sodium-bearing tank waste that is acceptable to stakeholders.

- An on-line process monitor is needed for elemental analysis of the calcine product.

- Glass formulations are needed for immobilization of the high-activity waste fraction of the sodium-bearing liquid waste and calcine.

- Final waste acceptance criteria are not yet available for the LLW grout.

- The Idaho Chemical Processing Plant must retrieve calcined waste from stainless steel bins. Key challenges to retrieving calcine wastes are limited working space, high

radiation levels, and the need for cost-effective technology to decontaminate the bins after calcine removal.

- Risk-based closure criteria is needed that defines the level to which tanks and bins must be cleaned before closure.

A.2.2.2 INEEL Programmatic Risks

INEEL is struggling to meet regulatory requirements to cease use of a number of existing tanks. This is especially true since the settlement agreement between the Governor of Idaho and DOE Idaho Operations Office requires that the 11 tanks be taken out of service by 2012, an acceleration of 3 years over the Federal Facility Agreement and Consent Order.

The plan is for requirements to empty existing tanks to be met with waste minimization and calciner campaigns. Delays in conducting calciner campaigns are affecting tank capacities. Calcine campaigns need to begin as scheduled or the regulatory agreement will not be met.[(a)]

Based on DOE's future funding projections, the costs for proposed INEEL treatment facilities will exceed available funding. This is especially true since schedules for HLW remediation have been accelerated.

A.2.2.3 INEEL Health and Safety Risks

INEEL does not withdraw or use surface water for site operations nor does it discharge effluents to the natural surface water. However, the Snake River Plane aquifer below INEEL is a sole source aquifer (DOE-ID 1995b, App. B). HLW treatment is of great interest to the State of Idaho because of the potential for HLW to be stored over the aquifer. Long-term risk to the public is possible from migration of tank residuals, tank leaks to the groundwater, or any other inadvertent release of HLW to the environment.

Some reasons or concern about inadvertent release at INEEL include the potential for near-term environmental, safety, and health risks if flammable gas generation occurs in the tank heels. This risk is being investigated by better characterizing the tank heels. There is also a seismic issue within bin set 1 due to an overstress on the vault walls. The likelihood of failure during an earthquake is unknown.

(a) Gurley, R. Director High-Level Waste Management, Lockheed, Idaho Technology Company. February 8, 1996. "TFA Requests for High Priority TD Schedules and Dates-RNG-22-96." Letter to RK Quinn, Technical Manager Tanks Focus Area, Pacific Northwest National Laboratory, Richland, Washington.

A.2.3 Oak Ridge Reservation Risks

The tanks at the Oak Ridge Reservation contain liquid LLW, which reduces exposure risks and makes the site a desirable location for prototype testing of tank remediation technology. Risks are discussed briefly in the following sections.

A.2.3.1 Oak Ridge Reservation Technical Risks

The technology needs - to reduce technical risks at Oak Ridge Reservation - involve the following:

- In situ tank and waste characterization methods to support remediation decisions and regulatory drivers.
- Mechanical mixing and mobilization equipment for bulk sludge retrieval and slurry transport.
- End effectors and deployment systems for heel waste retrieval and characterization for gunite and associated tanks CERCLA treatability studies.
- Waste forms and waste form production processes for immobilizing HLW sludges and secondary wastes.
- Cesium, strontium, technetium, and TRU separations and immobilization processes for supernate, sludges, newly generated waste, and source treatment.
- Tank closure criteria and strategies to resolve ambiguous tank closure requirements.

The relative importance of these technical risks depends on whether waste is treated and disposed onsite or shipped offsite for treatment and disposal.

A.2.3.2 Oak Ridge Reservation Programmatic Risks

A strategy for remediating inactive tank wastes at Oak Ridge has not been developed to date: this introduces programmatic risk. Lower cost treatment strategies are being emphasized at Oak Ridge in response to substantial reductions in DOE budgets. Particular emphasis is being placed on modifying and using existing facilities whenever possible, instead of constructing new facilities to reduce costs. Commercial treatment is being encouraged, and several proof-of-process awards are being negotiated.

A.2.3.3 Oak Ridge Reservation Health and Safety Risks

Surface water is the main source of potable water supplies at Oak Ridge. Water quality in the Clinch River is affected by Oak Ridge activities. The Clinch River supplies most of the

water to the site, the city of Oak Ridge, and other cities along the river. The fact that water resources near the site are used by the public (DOE-ID 1995b, App. F) makes secondary containment, leak detection, and water balance monitoring very important for preventing human health risk.

A.2.4 Savannah River Site Risks

Tank retrieval has been initiated and process development is well underway. There are risks that must be addressed associated with in-tank precipitation restart and safe retrieval of waste from HLW tanks. These risks are addressed in the following sections.

A.2.4.1 SRS Technical Risks

The SRS's primary interests are to minimize tank leaks during storage and retrieval, to minimize the generation of secondary wastes, and to enhance baseline technology, including the following:

- Improved tank instrumentation to measure tank corrosion and annulus inspection devices.
- Improved slurry pumps and mixing techniques for removing tank wastes and methods to reduce sludge settling and compaction during retrieval.
- Methods to remove tank heels, mired equipment, and hard sludges from tanks.
- Ion-exchange equipment and new resins for cesium removal as an alternative to in-tank precipitation.
- Improved Defense Waste Processing Facility laboratories and analytical methods for feed and waste form testing and improved product composition control systems.
- Recycle stream treatment and other methods to minimize secondary waste production.
- Technology to extend the life of Defense Waste Processing Facility melters.
- Optimize canister loading
- Optimize saltstone loading

A.2.4.2 SRS Programmatic Risks

SRS 2006 Plan (DOE-SRS 1997) goals are to remove waste from 24 high risk tanks and immobilize 37% of the HLW. Top site priorities include increased canister production, ITP restart in FY98 and couple with DWPF in FY99, demonstrating waste retrieval and tank closure, and optimizing HLW and saltstone loading. Goals, objectives, and program drivers

are captured in the sites HLW program plan (WSRC 1997). Restart of ITP and accelerated canister production will require additional budget above previous estimates. Budget cuts and loss of core competency are making it difficult for SRS to respond to operational problems.

A.2.4.3 SRS Health and Safety Risks

Groundwater contamination is a concern for the public, because the aquifer below the SRS is at an average depth of 9 m to 13 m (30 ft to 40 ft) below the surface. Reportedly, several of the tanks are in the groundwater table during some periods of the year. This is not of immediate concern because the drinking water is from the Savannah River or a deeper aquifer several hundred feet below the site. However, contamination in the shallow aquifer can move vertically toward deeper aquifers or horizontally toward the river. Efforts to reduce tank leakage during storage and retrieval are important to minimizing health and safety risk from future groundwater contamination.

A.3 Stakeholder Involvement and Issues

The Tanks Focus Area technology development program seeks to reflect the issues and concerns of stakeholders, including regulators and technology users at each of the sites. The Tanks Focus Area's objective is to work with the stakeholders in the evaluation of tank technologies considered for funding and deployment and to ensure that tests and demonstrations address stakeholders' and regulators' concerns. Environmental Management has established Site Technology Coordination Groups (STCGs) to facilitate this process. Site-specific advisory boards are the primary DOE forum for site-wide stakeholder involvement. The Community Leaders Network (CLN) also provides a means for the Tanks Focus Area to involve stakeholders in tanks technology development.

The CLN is unique in that its diverse membership is capable of providing the TFA with site, regional, and national perspectives on various public and Tribal stakeholder issues associated with technology development and deployment. In fact, there are CLN participants who are community residents of the four major DOE Tanks as well as all the major sites within the DOE Complex. Through their informal deliberations and interactions, CLN participants communicate between and among themselves and DOE representatives, and exchange information and "lessons learned" on public and Tribal involvement in technology development.

Stakeholder involvement and concerns are similar across the TFA sites. The following sections describe the TFA strategy for stakeholder involvement at each of the sites and a preliminary discussion of the issues being addressed.

A.3.1 Hanford Site

The Hanford STCG has the ability to represent stakeholders' views and concerns. The group has two levels: the management council and four subgroups affiliated with the four national

focus areas. The STCG tanks subgroup provides a direct way for the Tanks Focus Area to work with the larger group and stakeholders in evaluating tanks technology.

Regulators, representatives of environmental and public interest groups, representative of the TWRS program, and Native American tribes serve on the Hanford STCG management council. Three stakeholders on the management council are members of the Hanford Advisory Board that addresses major policy issues related to Hanford cleanup. Several members of the Hanford STCG also serve on the Community Leaders Network tanks subcommittee.

According to the Hanford Tanks Waste Task Force (1993), Hanford stakeholders are very concerned with safe storage of tank waste. They are concerned that cleanup proceed more quickly and that dollars be allocated to areas of the greatest need, including the remediation of tank waste. Stakeholders support prioritizing tank problems, so that limited dollars are spent wisely. The renegotiated Hanford Federal Facility Agreement and Consent Order reflects public concern over potential radiation exposure to users of the Hanford Reach and the Columbia River. The public repeatedly said that mixing tank waste with grout was unacceptable, and the new Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1994) replaces grout with a retrievable glass waste form.

The Hanford Advisory Board provides advice on tank waste treatment issues. The Board supports maintenance of TPA milestones and the concept of privatization. The Board is concerned that funds will not be available to support Phase 1 privatization. The Board urges DOE to conduct contingency planning and develop an alternate path forward. The Board also recommends further characterization and modeling of the vadose zone below the tank farms. Such data collection and modeling is needed to better understand risks from tank retrieval and tank farm closure.

Building upon prior successful interactions between the TFA and its stakeholders, a "Community Leaders Network (CLN) - Hanford Site Stakeholder Retreat" was held in May 1997. CLN participants comprising the TFA subgroup focused their individual comments and perspectives on tanks issues related to innovative technology development and deployment at the four major DOE tank waste sites. Other Hanford stakeholders in attendance included local Tribal representatives (Nez Perce), Hanford Advisory Board members, STCG representatives, and Washington and Oregon State regulators.

Key issues addressed during the Spring 1997 TFA Retreat included: stakeholder interactions between CLN and STCG representatives from DOE Tank Sites; the TFA Stakeholder Involvement Plan; stakeholder guidelines on both the scope and process for the "Contingency Planning for Tank Science and Technology Investments" initiative; tank waste acceptance criteria, and the Hanford Privatization effort; the Hanford Tank Initiative (HTI), retrieval performance, and tank closure and monitoring specifications; and TFA demonstration and deployment issues and opportunities.

A.3.2 Idaho National Engineering and Environmental Laboratory

The STCG at INEEL has been incorporated into the Environmental Management Integration Team. One member of the Environmental Management Integration Team serves as liaison with the INEEL tanks program. Another member is the team's link with the INEEL Site-Specific Advisory Board.

Stakeholders at INEEL want waste treatment to progress using the best-available technology. INEEL is focusing on technology development for treating high-level calcine wastes, i.e., getting these wastes into a form for near- and mid-term storage (approximately 50 years). They are particularly concerned with protecting the Snake River Aquifer. Stakeholders do not want INEEL to become a permanent waste repository. Waste treatment technology should be cost-effective, and privatization should be considered when appropriate. Areas of greatest risk should be addressed first. Plans for site treatment should be risk driven, based on the quantity of waste, its physical characteristics, its radioactivity, and subsequent risks to workers, the public, groundwater, and air quality.

A.3.3 Oak Ridge Reservation

The Oak Ridge STCG consists of a policy-making group and subgroups affiliated with each focus area including tanks. A principal focus of the STCG's activity has been to develop a comprehensive needs assessment for the site. The leaders of the subgroups and the STCG coordinator are developing methods and criteria for ranking needs across the subgroups.

DOE Oak Ridge Operations has developed an Environmental Management Public Involvement Program. A site-specific advisory board for the site is being established. A Local Oversight Committee was set up by the state of Tennessee and the site established a Citizens Advisory Board of about 20 people. This board is a potential point of contact for understanding stakeholder concerns.

Oak Ridge stakeholders are concerned with tank integrity, final disposition of tank waste, and remediation cost and schedules. Tank integrity must be ensured to prevent both catastrophic failure and slow leakage into the soil and groundwater. Stakeholders want DOE to select an ultimate disposal site for tank waste and to define waste acceptance criteria so that Oak Ridge waste can be sent for disposal. Finally, Oak Ridge stakeholders want cleanup to progress within a reasonable timeframe and at reasonable costs (DOE-ORO 1995).

A.3.4 Savannah River Site

The primary goal of the STCG at SRS is to facilitate implementation of needed technologies and to save time and money in the process. The STCG has a HLW subgroup with responsibility for defining site technology needs for tank waste remediation.

In addition to convening public meetings to engage the public in development of waste management strategies, SRS seeks stakeholder input through its Citizens Advisory Board (CAB). Over the past year, SRS has provided numerous briefings on its plan and approach for closure of HLW tanks and its workings with SCDHEC and EPA. As a result of these coordinated activities, the CAB issued formal recommendation in January 1996 that SRS complete its work on the Tank Farm Closure Plan by the end of FY97 (an objective SRS achieved in July 1996). CAB support continues to be strong. SRS has also surveyed its customers, including SCDHEC, EPA, and the CAB, questioning the effectiveness of SR's involvement of its regulators and the public in decision making, the level of trust and confidence in SRS, and suggestions for improvement. The response to this survey was very favorable, and SRS's interactions with its stakeholders during the development of the Tank Farm Closure Plan was specifically cited as noteworthy achievement in stakeholder involvement.

The SRS STCG has identified stakeholder issues of concern for HLW tanks. Many of these tanks have exceeded their design life. Aging tanks must be monitored for leaks. Stakeholders would like to see the waste removed from the old tanks as quickly as possible. Once the tanks are emptied, stakeholders want to be assured that effective technologies for decontamination, decommissioning, and closure are available.

A.4 Site Baselines and Tanks Focus Area Relationships

Beginning in this edition of the MYPP, the TFA will portray its understanding of each major tank site's baseline. Knowledge of the baseline schedules is essential to better understand where and when the TFA can make maximum impacts. This first attempt at graphically describing the site baselines will expand next year with the identification of technology insertion points along the baselines. Following are brief summaries of the major TFA activities and their relationship to the sites' baseline schedule through the year 2006. Referenced baseline schedule items are underlined in the narrative for identification. Site needs that may be important to the baseline in the future are also identified.

A.4.1 Hanford Site Baselines and Tanks Focus Area Relationships

Tanks Focus Area technologies that address important Hanford needs and baseline activities identified in Figure A.6 include the following:

- Hanford Tanks Initiative to establish retrieval performance criteria in support of SST Waste Retrieval and closure (M.45-06-T02).

- Corrosion probe and corrosion inhibitor monitoring to increase sensitivity and extend monitor life in support of Tank Farm Upgrades.

- Methods and instrumentation for determining waste product acceptability from private vendors in support of LAW Treatment.

- Saltcake dissolution studies to ensure prevention and reprecipitation of solids during transfer to support DST Waste Retrieval and LAW Treatment feed to privatization vendors.

- Sludge washing and settle/decant studies to investigate unwanted formation of solids in leachates, improving chromium removal, and ensuring performance of baseline system to support Phase II privatization (HLW Treatment and LAW Treatment).

- Retrieval technologies to enhance or replace past-practice sluicing of sludges and tank heels in support of SST Retrieval.

- Variable depth fluidic sampling system for monitoring feeds prior to delivery to the Phase I vendor in support of HLW Treatment and LAW Treatment.

- Standard methods for determining release of radionuclides to the environment from the ILAW in support of the performance assessment for LAW Storage and Disposal.

Several technical issues still challenge the current baseline waste management strategy. Several tank safety issues remain and scope deferrals are slowing down the process of tank safety issue resolution. Funding constraints limit testing of innovative closure technologies such as getter materials and surface barriers. Current vadose zone models are considered inadequate for supporting TWRS retrieval, disposal, and closure. A better understanding of vadose zone hydraulic properties is becoming a high priority need.

A.4.2 Idaho National Engineering and Environmental Laboratory Site Baselines and Tanks Focus Area Relationships

Tanks Focus Area is funding a number of technologies that address baseline activities at INEEL identified in Figure A.7 include the following:

- Acidic cesium/strontium/technetium/TRU removal technologies are being funded to handle the acidic liquid in INEEL tanks in support of the HLW EIS ROD and Title 1 Design.

- Crossflow filtration to remove undissolved solids from sodium-bearing wastes and dissolved calcine in support of the HLW EIS ROD and Title 1 Design.

- Process development to select equipment and processes for denitration of LAW in support of LAW Treatment.

- Advanced calcination process flowsheet that overcomes problems in calciner caused by melting of sodium and potassium in support of the State of Idaho Agreement to calcine all sodium-bearing waste.

- Evaluations of calcine dissolution behavior for design and scale-up of a calcine dissolver in

support of the HLW EIS ROD and Title 1 Design.

- Light Duty Utility Arm deployment so that tanks can be characterized prior to closure using appropriate end effectors in support of LAW Treatment and accelerated schedule to immobilize the heels of two tanks.

Idaho requires feasibility studies for the HLW-EIS decision process to select a baseline for treating and disposing of tank waste. By 2006, Idaho hopes to close 2 of 11 HLW tanks and to remediate eight buried mixed waste tanks.

A.4.3 Oak Ridge Reservation Baselines and Tanks Focus Area Relationships

The Tanks Focus Area addresses many of the technical risks and baseline activities at the Oak Ridge Reservation and identified in Figure A.8. In addition, a number of tests are planned at Oak Ridge that should reduce technical risks for all sites. A cesium removal demonstration was conducted in FY96 and FY97 using a full-scale modular cesium ion-exchange processing unit. A full-scale sub-atmospheric mobile evaporator underwent testing in FY95 and FY96. The Modified Light-Duty Utility Arm is being tested in gunite tank treatability studies in FY97, including retrieval and deployment of sampling end effectors. A demonstration of grout versus glass for immobilization of LAW in FY 97 and FY98 will assist the site in selecting full-scale technology for waste immobilization.

In addition to these past accomplishments, TFA activities currently addressing ORR baseline activities include:

- MLDUA and Houdini deployment platforms with the Confined Sluicing End Effector, Gunite Scarifying End Effector, and jet pump to retrieve gunite tank wastes in support of GAAT Tank Remediation.

- Wall coring, tank isolation, grout formulation, and grout emplacement technologies in support of GAAT Tank Remediation site closure.

- Fluidic pulse jets to mobilize sludge in support of BVEST Removal sludge transfer to MVST.

- Borehole miner/extendible nozzle to mobilize sludges from the Old Hydrofracture Tanks and transfer to MVST.

- Cross-flow filtration and sludge mapping tools in support of transfers to MVST and from MVST to treatment (MVST Treatment).

Oak Ridge may be able to ship a substantial portion of the waste offsite for treatment. If this option proves viable, the need for technology development to treat waste at Oak Ridge may need to be examined. The ability to transfer technologies demonstrated at the Oak Ridge Reservation

to other sites is of particular concern. Efforts must be made to ensure that available MVST waste streams are supplemented with hot waste samples from other sites if the constituents of concern at those sites are not represented in the MVST waste.

A.4.4 Savannah River Site Baselines and Tanks Focus Area Relationships

Tanks Focus Area is addressing a number of needs to enhance the baseline identified in Figure A.9 at SRS including:

- Waste loading improvement to DWPF glass from better defining the acceptable processing window for HLW vitrification plants in support of Vitrification.
- Methods for controlled salt dissolution using density gradient methods for saltcake retrieval to support SRS Salt Removal.
- Out-of-tank evaporator to concentrate waste feed to the saltstone process in support of cost reduction for Fill Saltstone Vaults.
- Heel retrieval methods to remove sludge and debris remaining on the bottoms of waste tanks after bulk waste removal in support of SRS Sludge Removal and SRS Tank Closure.
- Specifications and procurement of metal filters for waste tank ventilation to reduce tank operations costs and worker risk in support of H & F Tank Farm operations..
- DWPF pour spout enhancements that eliminate DWPF downtime due to pour spout plugging in support of Vitrification and canister production.
- Monitors for determining tank corrosion and process tank level and material density in support of H & F Tank Farm operations and Extended Sludge processing.

The TFA is committed to developing a baseline approach to closing HLW tanks. Tank 20 is closed and efforts are progressing toward closure of Tank 17. Results of tank closure at SRS will benefit the rest of the complex. Emphasis is now on retrieval of wastes to support DWPF operations, restart of ITP, and continued closure of tanks. A number of enhancements to the equipment design and operability of the DWPF melter system remain high priorities for future technology development.

A.5 Next Steps

The Tanks Focus Area is examining relative risks and costs across the complex to ensure that its program addresses needs with the greatest risk and its solutions offer significant risk and cost reductions worthy of its investments. The Tanks Focus Area will build on risk, cost, and environmental consequence information from these and other sources to compare risk across sites and to enhance cost-risk tradeoffs relevant to technology developments decisions.

Additional stakeholder involvement is essential. Technology investment dollars are protected by involving stakeholders in the selection and evaluation of technology. Stakeholders can often point to innovative solutions or approaches that should be considered. The Tanks Focus Area will actively support site activities directed at involving stakeholders in technology demonstrations and deployment decisions.

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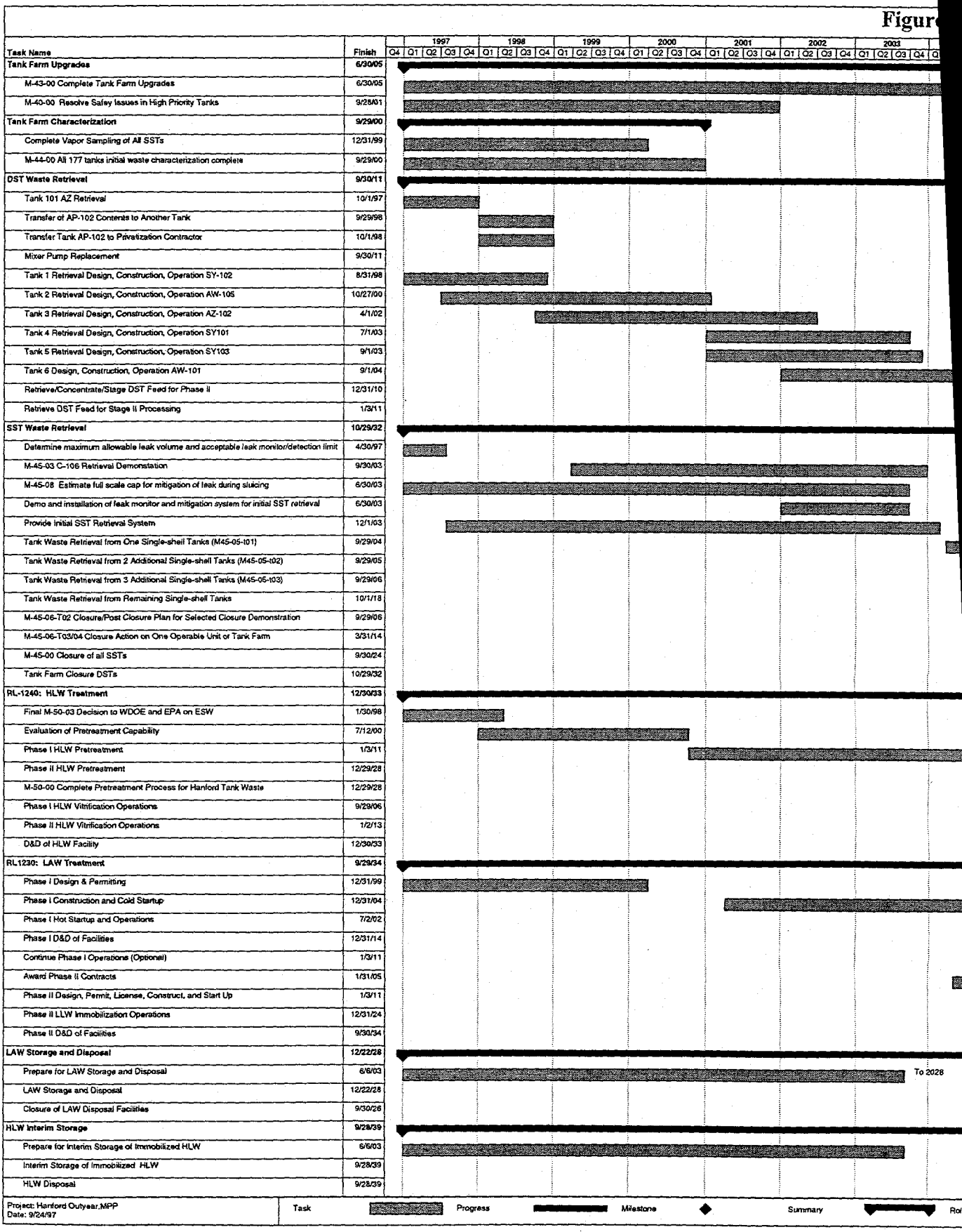
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Figur



Task Name	Finish
Tank Farm Upgrades	6/30/05
M-43-00 Complete Tank Farm Upgrades	6/30/05
M-40-00 Resolve Safey Issues in High Priority Tanks	9/25/01
Tank Farm Characterization	9/29/00
Complete Vapor Sampling of All SSTs	12/31/99
M-44-00 All 177 tanks initial waste characterization complete	9/29/00
DST Waste Retrieval	9/30/11
Tank 101 AZ Retrieval	10/1/97
Transfer of AP-102 Contents to Another Tank	9/29/98
Transfer Tank AP-102 to Privatization Contractor	10/1/98
Mixer Pump Replacement	9/30/11
Tank 1 Retrieval Design, Construction, Operation SY-102	8/31/98
Tank 2 Retrieval Design, Construction, Operation AW-105	10/27/00
Tank 3 Retrieval Design, Construction, Operation AZ-102	4/1/02
Tank 4 Retrieval Design, Construction, Operation SY101	7/1/03
Tank 5 Retrieval Design, Construction, Operation SY103	9/1/03
Tank 6 Design, Construction, Operation AW-101	9/1/04
Retrieve/Concentrate/Stage DST Feed for Phase II	12/31/10
Retrieve DST Feed for Stage II Processing	1/3/11
SST Waste Retrieval	10/29/32
Determine maximum allowable leak volume and acceptable leak monitor/detection limit	4/30/97
M-45-03 C-106 Retrieval Demonstation	9/30/03
M-45-08 Estimate full scale cap for mitigation of leak during sluicing	6/30/03
Demo and installation of leak monitor and mitigation system for initial SST retrieval	6/30/03
Provide Initial SST Retrieval System	12/1/03
Tank Waste Retrieval from One Single-shell Tanks (M45-05-t01)	9/29/04
Tank Waste Retrieval from 2 Additional Single-shell Tanks (M45-05-t02)	9/29/05
Tank Waste Retrieval from 3 Additional Single-shell Tanks (M45-05-t03)	9/29/06
Tank Waste Retrieval from Remaining Single-shell Tanks	10/1/18
M-45-06-T02 Closure/Post Closure Plan for Selected Closure Demonstration	9/29/06
M-45-06-T03/04 Closure Action on One Operable Unit or Tank Farm	3/31/14
M-45-00 Closure of all SSTs	9/30/24
Tank Farm Closure DSTs	10/29/32
RL-1240: HLW Treatment	12/30/33
Final M-50-03 Decision to WDOE and EPA on ESW	1/30/98
Evaluation of Pretreatment Capability	7/12/00
Phase I HLW Pretreatment	1/3/11
Phase II HLW Pretreatment	12/29/28
M-50-00 Complete Pretreatment Process for Hanford Tank Waste	12/29/28
Phase I HLW Vitrification Operations	9/29/06
Phase II HLW Vitrification Operations	1/2/13
D&D of HLW Facility	12/30/33
RL1230: LAW Treatment	9/29/34
Phase I Design & Permitting	12/31/99
Phase I Construction and Cold Startup	12/31/04
Phase I Hot Startup and Operations	7/2/02
Phase I D&D of Facilities	12/31/14
Continue Phase I Operations (Optional)	1/3/11
Award Phase II Contracts	1/31/05
Phase II Design, Permit, License, Construct, and Start Up	1/3/11
Phase II LLW Immobilization Operations	12/31/24
Phase II D&D of Facilities	9/30/34
LAW Storage and Disposal	12/22/28
Prepare for LAW Storage and Disposal	6/6/03
LAW Storage and Disposal	12/22/28
Closure of LAW Disposal Facilities	9/30/26
HLW Interim Storage	9/28/39
Prepare for Interim Storage of Immobilized HLW	6/6/03
Interim Storage of Immobilized HLW	9/28/39
HLW Disposal	9/28/39

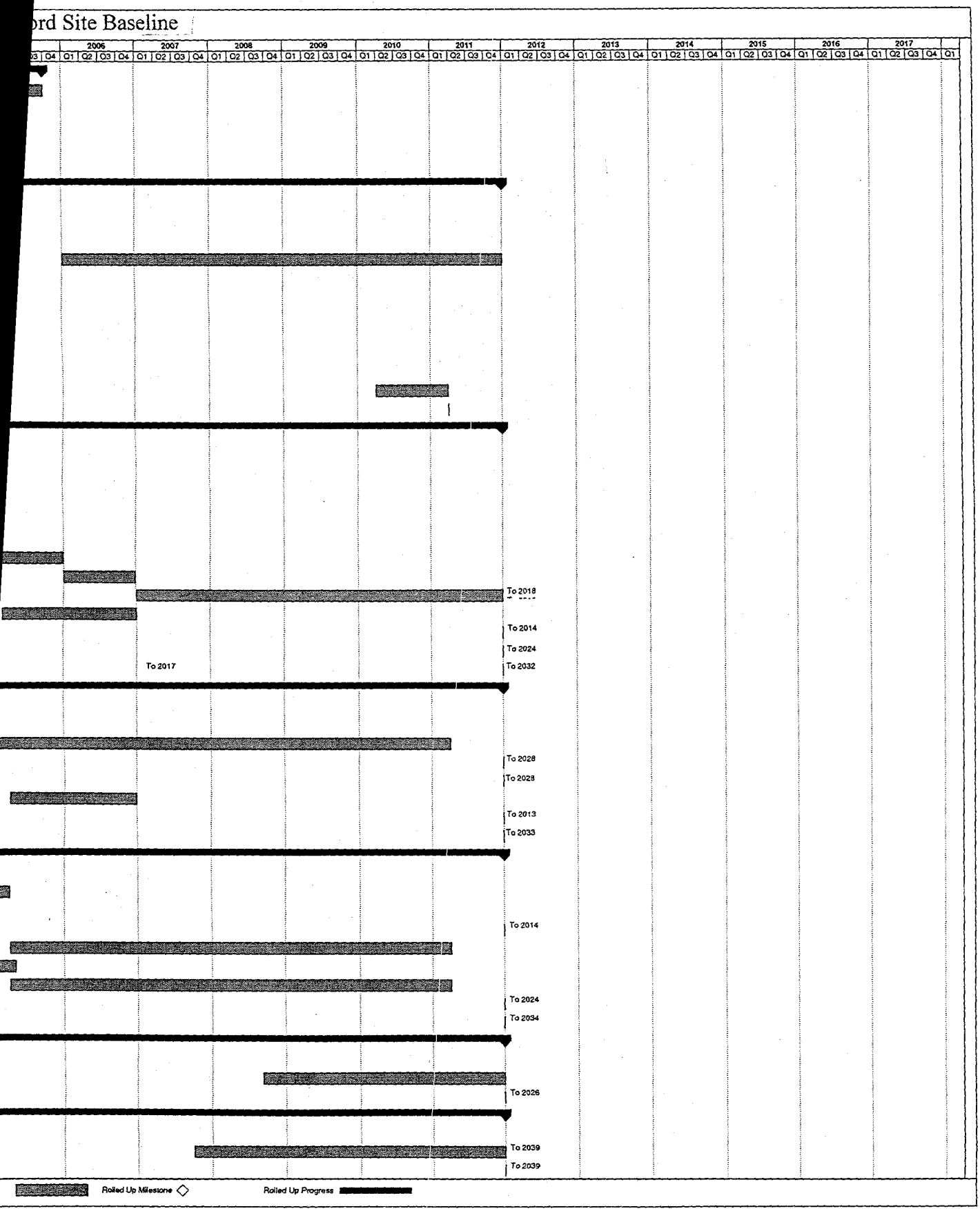
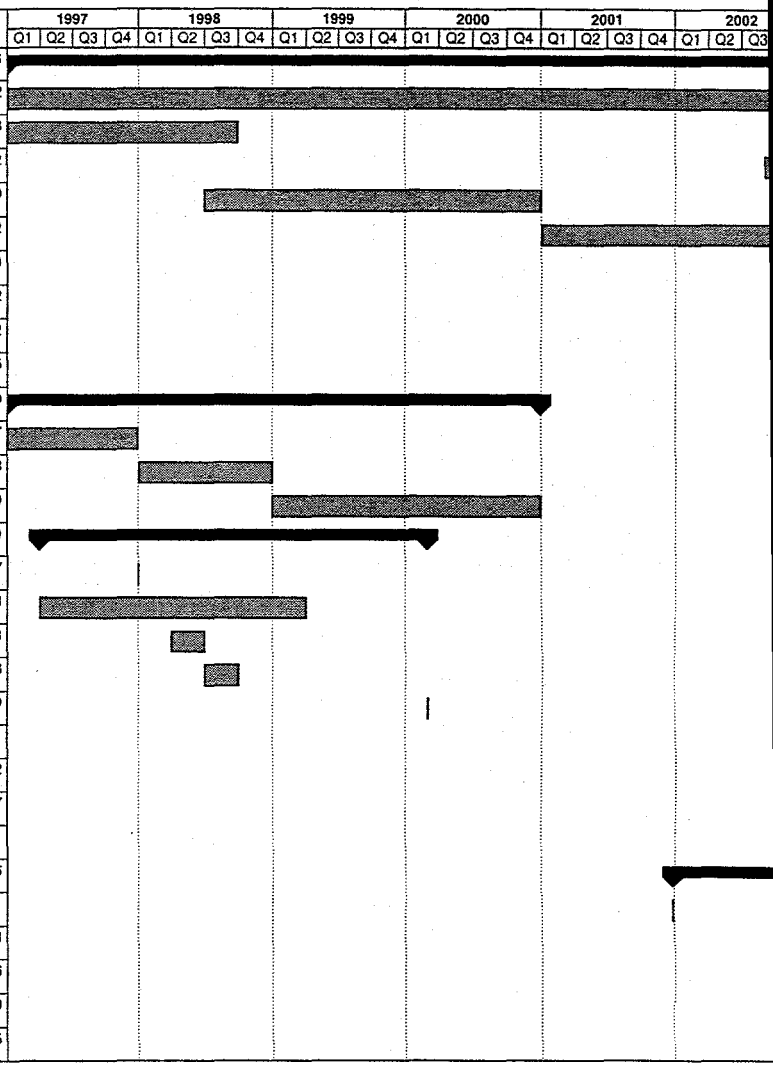

ord Site Baseline
2006
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2017
Q1 Q2 Q3 Q4
To 2018
To 2014
To 2024
To 2032
To 2017
To 2028
To 2028
To 2013
To 2033
To 2014
To 2024
To 2034
To 2026
To 2039
To 2039
Rolled Up Milestone
Rolled Up Progress

Figure A.7. Idaho National E

Task Name	Finish
State of Idaho Agreement	**12/31/35**
Operate High Level Liquid Waste Evaporator	12/28/12
Calcine All Non-sodium Bearing Waste	6/30/98
Calcine All Sodium Bearing Waste	12/28/12
Construct Debris Treatment Facility	9/29/00
Operate Debris Treatment Facility	9/28/12
Cease Use of Pillar and Panel Tanks	4/1/09
Pillar and Panel Tanks Heel Removal	12/28/12
Cease Use of All Tanks w/o Secondary Containment	12/31/12
Move All HLW out of Idaho	12/31/35
V Tank Closure	**9/29/00**
Risk Assessment Based on Source Term	9/30/97
Record of Decision	9/30/98
Remediation	9/29/00
HLW Environmental Impact Statement	**12/1/99**
EIS Scoping Meeting	10/1/97
Prepare Draft EIS	12/31/98
Public Comment	4/1/98
Issue Final EIS	7/1/98
Issue ROD	12/1/99
HLW Immobilization Facility (Privatized)	**10/1/31**
Detailed Facility Design	9/28/12
Facility Construction	9/29/17
HAW Storage Modules	10/1/31
LAW Treatment (Privatized)	**12/31/35**
Detailed Grout Facility Design	9/28/01
Construction of the LAW Grouting Facility	9/30/03
Provide Grout to ImmobilizeHeels of Two Tanks	9/29/06
Grout Newly Generated Liquid Waste	9/30/20
Grout Waste Form Radionuclide Separations	12/31/35



Project: INEEL Outyear.MPP
Date: 9/24/97

Task Progress Milestone S

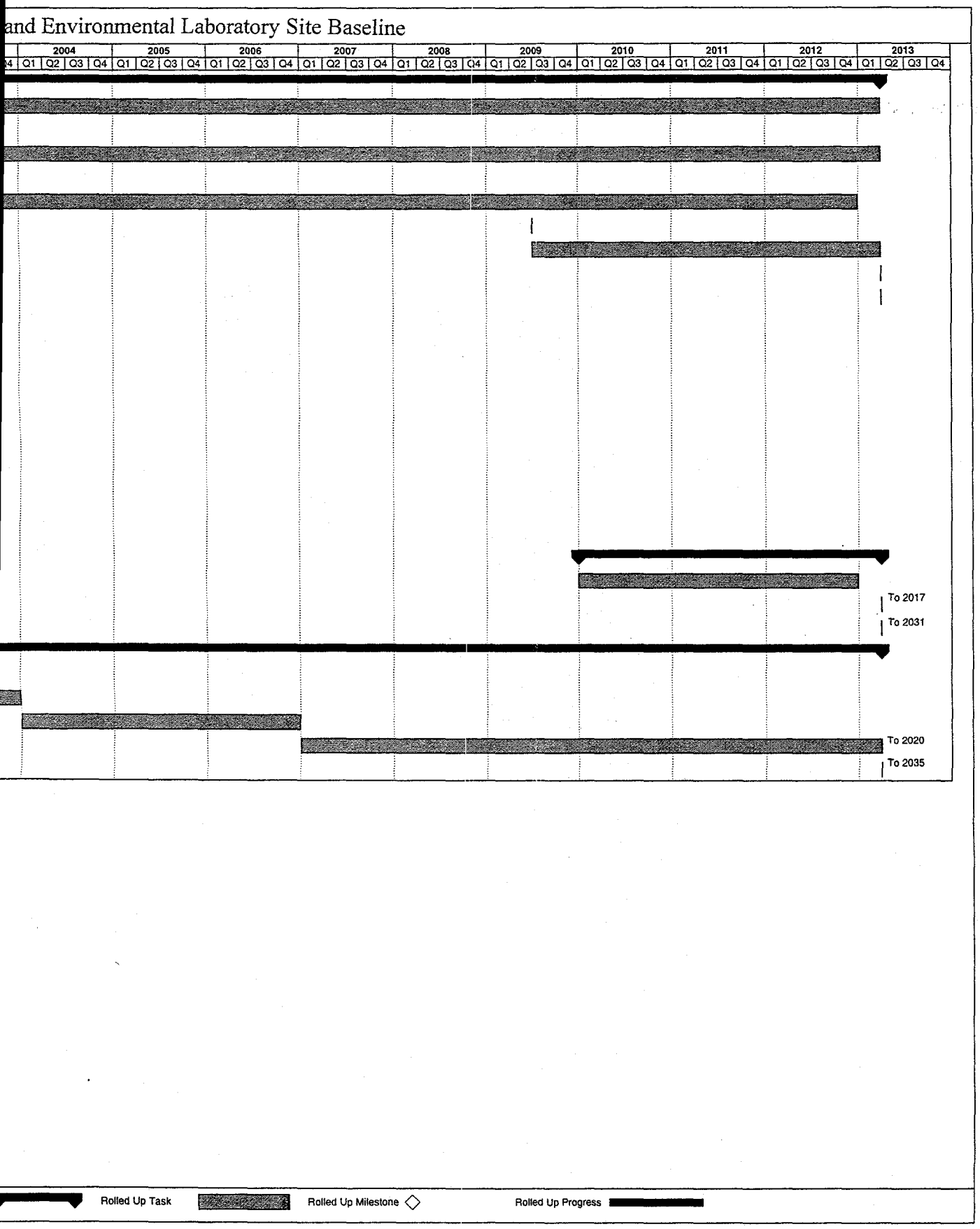
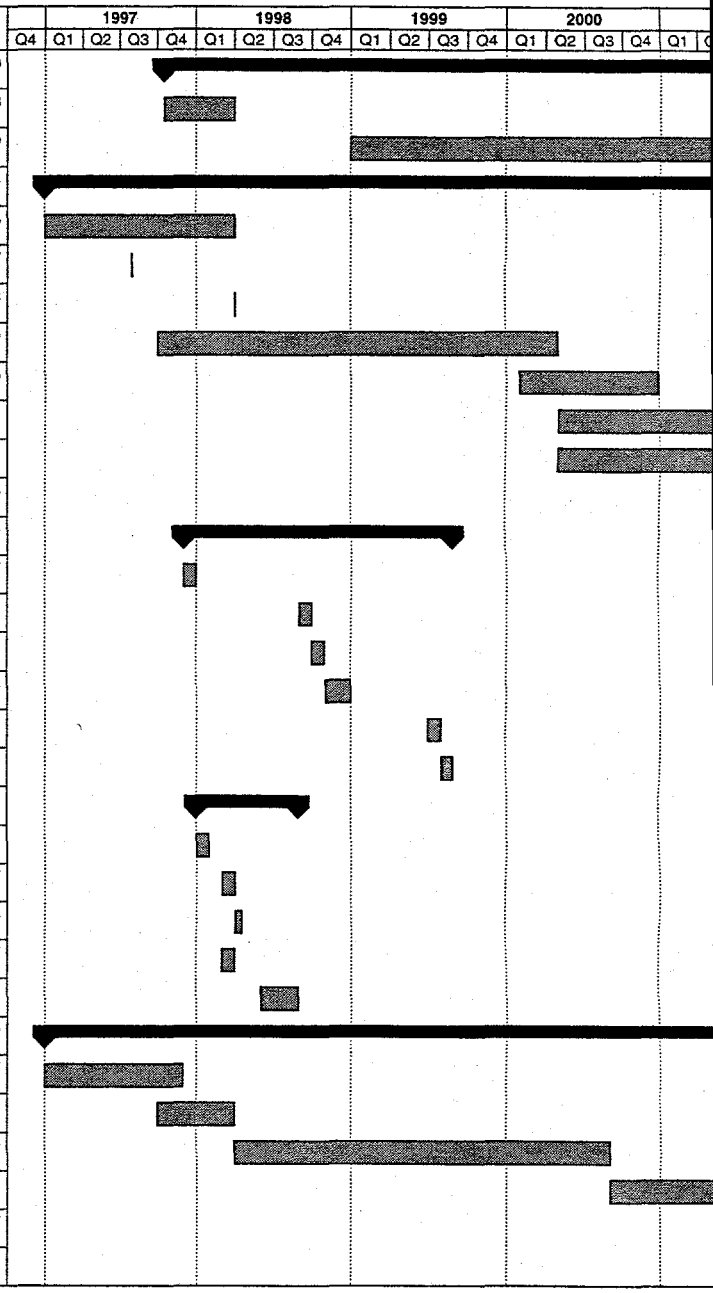

and Environmental Laboratory Site Baseline
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Q1 Q2 Q3 Q4
To 2017
To 2031
To 2020
To 2035
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

Figure A.8. C

Task Name	Finish
Environmental Management Contract	**9/30/10**
Award Contract	1/1/98
Complete treatment and disposal of Low Level Legacy Waste	9/30/10
GAAT Tank Remediation	**2/28/06**
GAAT Treatability Study	1/1/98
GAAT Groups 1& 2 ROD	4/30/97
GAAT Group 3 ROD	1/1/98
GAAT Consolidation Activities	1/31/00
GAAT Site Closure	9/29/00
GAAT Group 1&3 Remedial Action Report	4/30/01
GAAT Group 3 Remedial Action Report	9/28/01
Bethel Valley Contaminated Soils Remedial Acton Report	2/28/06
BVEST Removal	**5/28/99**
Transfer BVEST W-21 to MVSTs	9/30/97
OTE Campaing No. 4	6/30/98
Transfer BVEST W-22 to MVSTs	7/31/98
Transfer BVEST W-23 to MVSTs	9/30/98
Transfer BVEST C-1 to MVSTs	4/30/99
Transfer BVEST C-2 to MVSTs	5/28/99
Old Hydrofracture Tanks	**5/29/98**
OTE Campaign No. 1	10/30/97
OTE Campaign No. 2	12/31/97
Transfer OHF T-1 to MVSTs	1/15/98
OTE Campaign No. 2	12/31/97
Transfer OHF T-2, T-4, T-3, T-9 to MVSTs	5/29/98
Melton Valley Storage Tanks Waste Treatment	**6/2/09**
Cesium Removal Demonstration	8/29/97
Award contract for TRU Waste Treatment (RFP No. DE- RP05-98	12/30/97
Phase I: Licensing and permitting	6/1/00
Phase II. Construction and Testing	5/31/02
Phase III. Process waste shipments	6/1/07
Phase IV. D&D of Facilities	6/2/09



Project: Oak Ridge Outyear.MPP
Date: 9/24/97

Task Progress Milestone

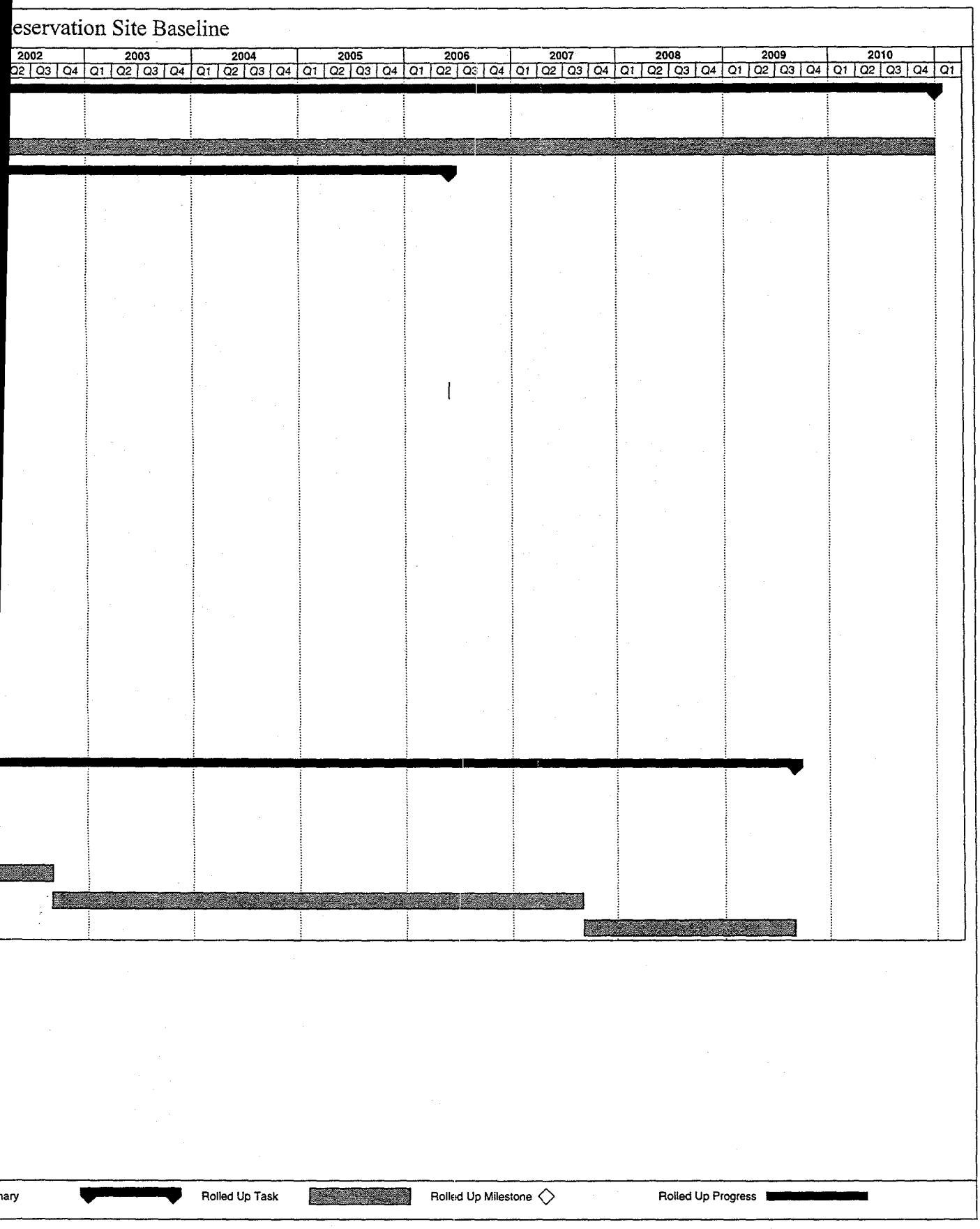

eservation Site Baseline
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nary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

Figure A.9. Sava

Task Name	Finish
H & F Tank Farm	9/29/06
RHLWE Radioactive Operations	6/30/99
Achieve Annual Evaporator Space Gains	9/29/06
SRS Sludge Washing	9/29/06
Tank 40 Sludge Washing	9/29/00
Tank 42 Sludge Washing	9/30/98
Tank 51 Aluminum Dissolution and Sludge Wash of Tank 11	6/30/03
Tank 40 Aluminum Dissolution and Sludge Wash of Tank 12&14	9/30/05
Tank 51 Aluminum Dissolution and Sludge Wash of Tank 15	9/29/06
SRS Sludge Removal	9/29/06
Tank 19 Sludge Removal	6/30/98
Tank 8 Sludge Removal facilities	12/29/00
Tank 11 Sludge Removal facilities	9/30/02
Tank 18 Sludge Removal	12/31/99
Tank 7 Sludge Removal	4/30/03
Tank 12 & 14 Sludge Removal	3/31/04
Tank 4 Sludge Removal	9/30/05
Tank 15 Sludge Removal	9/29/06
Tank 5,6,21,22 Sludge Removal	9/29/06
SRS Salt Removal	9/29/06
Tank 25 Salt Removal facilities	4/28/00
Tank 29 Salt Removal facilities	4/30/02
Tank 16 Annulus Salt Removal	12/1/99
Tank 28 Salt Removal facilities (Start Salt Removal)	6/15/02
Tank 38 Salt Removal facilities (Start Salt Removal)	5/15/03
Tank 9 Salt Removal	9/30/05
Tanks 1 & 3 Salt Removal	2/1/06
Tanks 2 & 10 Salt Removal	9/29/06
Tank 41 & 47 Salt Removal	9/29/06
SRS Tank Closure	7/31/06
Closure of Tanks 17 & 20	9/30/97
Closure of Tank 8	11/30/01
Closure of Tank 18	9/29/00
Closure of Tank 19	4/30/99
Closure of Tank 16	4/30/99
Closure of Tank 11	7/30/03
Closure of Tanks 12 and 14	1/31/05
Closure of Tank 4 & 9	7/31/06
Closure of Tanks 1,2,3&7	7/3/06
Closure of all HLW Tanks	9/21/97
Closure of all Process Cells and Buildings	9/21/97
In Tank Precipitation	8/15/06
ITP Cycle 1	6/1/98
ITP Cycle 2	3/31/99
ITP Cycle 3-13	8/15/06
Extended Sludge Processing	9/29/06
Operate Late Wash	9/29/06
Vitrification	9/29/06
Pour 150 canisters of waste per year	9/30/97
Pour 200 canisters of waste per year	9/29/04
Pour 225 canisters of waste per year	9/30/05
Pour 250 canisters of waste per year	9/29/06
Operate Melters	4/29/05
Fill Saltstone Vaults	9/29/06

1997 Q4 | 1998 Q1 Q2 Q3 Q4 | 1999 Q1 Q2 Q3 Q4 | 2000 Q1 Q2 Q3 Q4 | 2001 Q1 Q2 Q3 Q4 | 2002 Q1 Q2

Batch 1A

Batch 1B

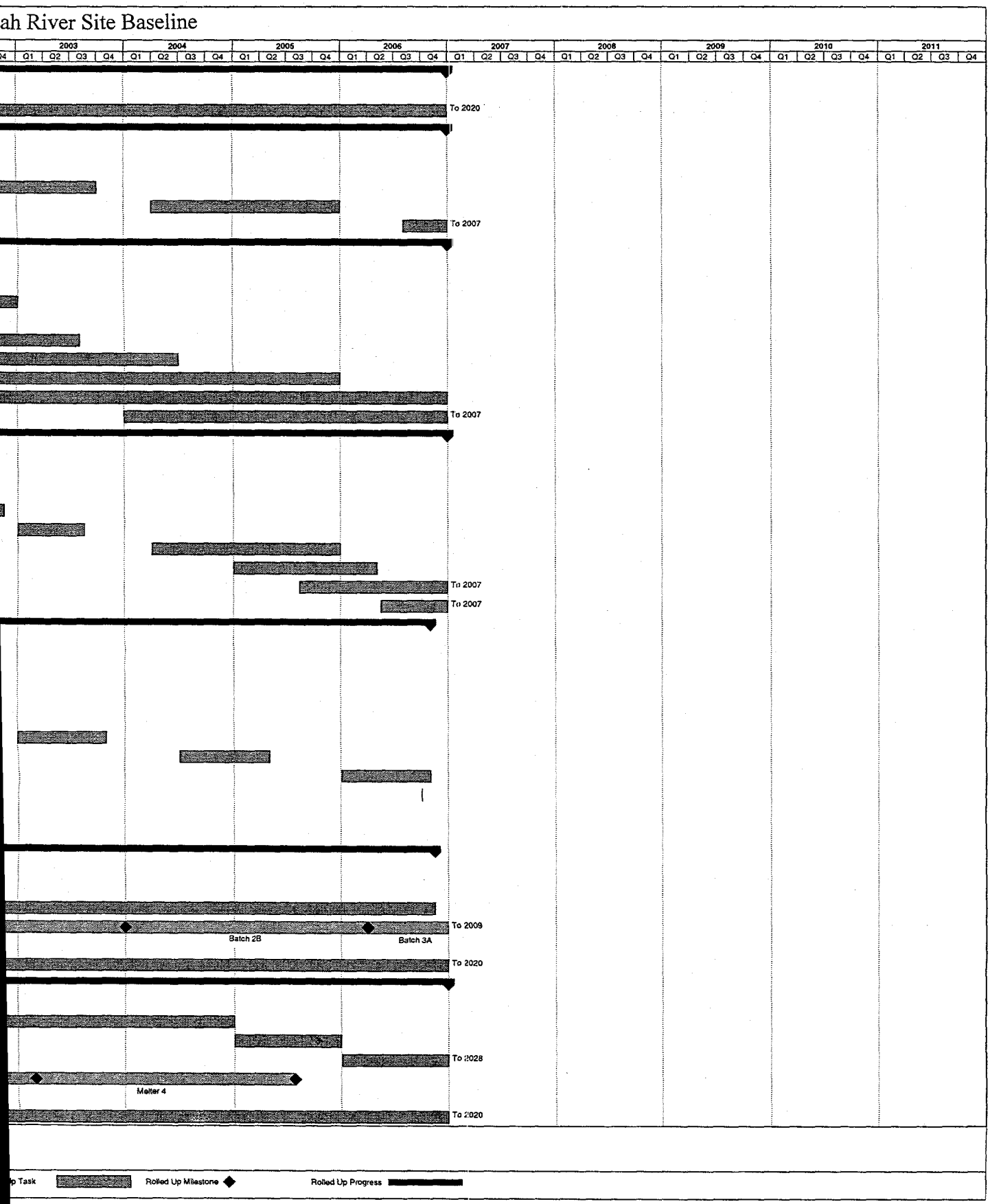
Melter 1

Melter 2

Melter 3

Project: SRS Outyear.MPP
Date: 9/24/97

Task | Progress | Milestone | Summary


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Q1 Q2 Q3 Q4
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To 2007
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To 2007
To 2007
To 2009
Batch 2B
Batch 3A
To 2020
To 2028
Melter 4
To 2020
Rolled Up Milestone
Rolled Up Progress

Appendix B - Problem Element Descriptions

The Tanks Focus Area (TFA) Technical Team constructed problem elements that describe areas of concern in high-level tank waste remediation. Into this structure were placed high-impact needs at the four tank sites: Hanford, Idaho National Engineering and Environmental Laboratory (INEEL), Oak Ridge Reservation (ORR), and Savannah River Site (SRS). These needs were determined from the needs assessment process, which is described in Section 2 of this document. These problem elements form the core of the TFA technical program and ensure that the program remains responsive to site needs, regardless of probable changes in site remediation baselines due to budget reductions, privatization, or changes in regulatory requirements and agreements. Together, the problem elements define a path forward to solve the fundamental remediation problems underlying specific site requests.

The problem elements were defined initially by the TFA Technical Team using the information from the needs assessment (TFA 1996) and in response to discussions with site users. Explicit criteria guiding problem element definition included the fundamental U.S. Department of Energy (DOE) objectives to reduce risks and costs.

The path forward for each element was also defined to minimize six constraints that typically undermine the success of technical activities:

- Technical uncertainty
- Deployability (or "system fit")
- Stakeholder and regulatory acceptability
- Development cost
- Schedule compatibility
- Application to changing baselines (alternative scenarios).

Each problem element was informally evaluated by the TFA Technical Team against these constraints to ensure that it represented a practical and potentially successful solution to site problems. The result of this evaluation indicated, for example, which problem elements promise cost reduction as their primary benefit and why (e.g., by minimizing secondary waste). More formal evaluation may be appropriate before defining specific tasks and scope for each element. Technical task plans (TTPs) that support the TFA's FY98-00 tasks will include more specific scope, schedule, and budget information on the problem elements.

B.1 Problem Elements

The TFA problem elements are described on the following pages; together, these problem elements form the core of the FY98-FY00 TFA program. Each element includes the following sections: Title, Problem Element Description, Priority Site Needs, Problem Statement, Path to Solution, FY98-FY00 Scope and Schedule, and Requested Budget. Table B.1 lists the problem elements; they are organized by breakdown structure number.

For clarity, the following problem elements consolidations have been made in Appendix B:

- 1.1.3.1 Characterize Waste In Situ and 1.1.3.3 Analyze Waste were consolidated into 1.1.3 Characterize Waste
- 1.1.4.1 Reduce Source Streams and 1.1.4.2 Reduce Recycle Streams were consolidated into 1.1.4 Reduce Waste Volumes
- 1.2.2.1 Calcine Waste and 1.2.2.2 Dissolve Waste
- 1.2.3.2.1 Monitor & Control HLW Immobilization Process, 1.2.3.2.3 Prepare Sludge Feed, and 1.2.3.2.4 Immobilize HLW Stream were consolidated into 1.2.3.2 Process HLW
- 1.3.1.2 Characterize Heels, 1.3.1.3 Define Closure Criteria, and 1.3.1.7 Stabilize Tank for Closure were consolidated into 1.3.1 Close Tanks
- 1.3.2.1 Monitor Waste for Acceptance and 1.3.2.2 Determine Performance of Waste Form were consolidated into 1.3.2 Dispose of LLW.

Table B.1. Problem Element List

Problem Element		Page Number
1.1.1	Extend Tank Life	B.9
1.1.2	Ventilate Tanks	B.13
1.1.3	Characterize Waste	B.16
1.1.4	Reduce Waste Volumes	B.22
1.2.1.2	Mobilize Bulk and Heel Wastes	B.25
1.2.1.4	Transfer Waste	B.32
1.2.1.5	Detect and Mitigate Leaks	B.36
1.2.1.6	Monitor and Control Retrieval Process	B.39
1.2.2.1	Calcine Waste and 1.2.2.2 Dissolve Waste	B.44
1.2.2.3	Prepare Retrieved Waste for Transfer and Pretreatment	B.47
1.2.2.4	Clarify Liquid Streams	B.50
1.2.2.5	Remove Radionuclides	B.53
1.2.2.7	Process Sludge	B.58
1.2.2.8	Prepare Pretreated Waste for Immobilization	B.63
1.2.3.1.3	Immobilize LLW Stream	B.66
1.2.3.2	Process HLW	B.69
1.3.1	Close Tanks	B.76
1.3.2	Dispose of LLW	B.85

Throughout Appendix B, the TFA uses the terms "PBS#" and "Technology ID" to further identify site needs and TFA responses to the needs. "PBS#" refers to the Program Baseline Summaries prepared by each site. The "Technology ID" number refers to the Office of Science and Technology's technology database reference number. Two additional tables help guide the reader through this appendix while using these terms.

Table B.2 provides the latest version of the TFA's integrated task priority listing. Each TFA response to a site need may be correlated to a specific problem element. Since this appendix is organized by problem element number, Table B.2 helps locate information about responses to specific needs. For FY98, present funding will permit work to be accomplished through TFA Priority #32 in Table B.2. The FY99-FY00 budget and work scope activities reflect unconstrained budget cases. If lower funding is provided, a number of activities will not be performed as described.

Table B.3 acts as a summary crosswalk. Within the appendix and Table B.3, not all information is known, such as some OST Technology ID# and Site PBS#. These have been marked as "N/A."

Table B.2. Tanks Focus Area FY98-FY00 Integrated Priority List

TFA Priority	TFA Resp#	Site	Problem Element Number	Technology Title	98$	99$	00$	FY98$ Total	FY99$ Total
1	623	SRS	1.2.3.2.4	Waste Loading Improvement for HAW Glass	400	430	200	400	430
2	614	SRS	1.2.1.2	Salt Removal Systems	800	800	150	1200	1230
3	607	Oak Ridge	1.2.1.6	Slurry Monitors	0	0	0	1200	1230
4	612	Oak Ridge	1.3.1.7	GAAT Tank Closure	800	500	150	2000	1730
5	645	Idaho	1.2.2.5	TRUEX/SREX for Idaho Pretreatment	575	750	100	2575	2480
6	679	Hanford	1.3.1.3	Hanford Tanks Initiative	7000	10000	10000	9575	12480
7	662	Hanford	1.1.1.1	Corrosion Probe and Corrosion Inhibitor Monitoring	395	550	300	9970	13030
8	675	Hanford	1.3.2.1	Waste Form Product Acceptance Testing	600	1000	1000	10570	14030
9	609	Oak Ridge	1.2.2.4	SLS for Melton Valley Storage Tanks	525	150	0	11095	14180
10	643	Idaho	1.2.2.4	CUF SLS for Idaho	200	0	0	11295	14180
11	647	Idaho	1.2.3.1.3	LAW Waste Form for Idaho (Grout)	800	900	1150	12095	15080
12	671	Hanford	1.2.2.3	Studies of Saltcake Dissolution and Concentrate Reprecipitation	425	450	0	12520	15530
13	672	Hanford	1.2.2.7	Control of Leachate Solids Formation	630	600	0	13150	16130
14	679A	Hanford	1.2.1.2	Enhanced Sluicing Systems	325	575	475	13475	16705
15	608	Oak Ridge	1.2.3.1.3	Grout & Glass Waste Forms for ORR	1250	0	0	14725	16705
16	632	SRS	1.2.2.8	OTE Deployment for SRS	525	500	0	15250	17205
17	606	Oak Ridge	1.2.1.2	Borehole Miner and Fluidic Jets for OHF and BVEST	425	125	0	15675	17330
18	613	SRS	1.2.1.2	Heel Retrieval for SRS	1125	1125	700	16800	18455
19	649	Idaho	1.2.3.2.4	Process for Idaho HAW Immobilization	700	800	1000	17500	19255
20	629	SRS	1.1.2	Metal Filters for Waste Tank Ventilation	50	200	100	17550	19455
21	674	Hanford	1.2.1.6	Variable Depth Fluidic Sampling and Analysis	500	400	300	18050	19855
22	610A	Oak Ridge	1.2.1.2	Waste Conditioning CPU	500	100	0	18550	19955
23	610B	Oak Ridge	1.2.1.2	Pulse Air	202	75	0	18752	20030
24	670	Hanford	1.3.2.2	ILAW Form Release Test	200	300	0	18952	20330
25	636	SRS	1.2.3.2.1	Level and Density Monitors	50	250	350	19002	20580
26	605A	Oak Ridge	1.2.2.5	Cesium Removal Demonstration	210	0	0	19212	20580
27	648	Idaho	1.3.1.2	LDUA Deployment at Idaho	2300	400	0	21512	20980
28	673	Hanford	1.2.2.7	Parametric Studies of Hanford Sludge Washing	1995	1995	0	23507	22975
29	604	Oak Ridge	1.3.1.7	GAAT Tank Isolation	470	300	0	23977	23275
30	610C	Oak Ridge	1.2.1.2	Jet Pump	398	125	0	24375	23400
31	633	SRS	1.2.3.2.4	DWPF Process and Pour Spout Enhancements (FIU)	560	300	0	24935	23700
32	640	Idaho	1.2.2.1	Advanced Calcination for Idaho	350	600	400	25285	24300
33	611A	Oak Ridge	1.1.3.1	GAAT Wall Coring	0	150	0	25285	24450
34	684	Hanford	1.3.1.3	Tank Site Closure Technology	0	400	1900	25285	24850
35	644	Idaho	1.2.2.2	Calcine Dissolution	0	420	600	25285	25270
36	678C	Hanford	1.2.2.4	Solid/Liquid Separation - Hanford	0	525	500	25285	25795
37	678A	Hanford	1.2.2.7	Settle Decant Sludge	0	525	700	25285	26320
38	611B	Oak Ridge	1.1.3.1	Sludge Mapping Tools	0	300	400	25285	26620
39	686	Hanford	1.3.2.2	Waste Form Surface Area Analysis	0	400	300	25285	27020
40	618	SRS	1.2.2.5	Application of Sorbents for SRS Radionuclide Removal	0	420	600	25285	27440

Table B.2. (contd)

TFA Priority	TFA Resp#	Site	Problem Element Number	Technology Title	98$	99$	00$	FY98$ Total	FY99$ Total
41	639	Idaho	1.1.4.1	Low Water Decontamination Systems for Idaho Chemical Processing Plant	0	525	475	25285	27965
42	637	SRS	1.2.2.8	Caustic Recovery and Recycle	0	825	1600	25285	28790
43	615	SRS	1.1.3.1	In Tank Na/K Monitor	0	300	300	25285	29090
44	619	SRS	1.1.4.2	CSTs for DWPF Recycle Streams	0	400	600	25285	29490
45	617	SRS	1.2.1.2	Tank Annulus Cleaning	0	200	800	25285	29690
46	620	SRS	1.2.2.7	Counter-Current Decantation	0	330	1000	25285	30020
47	625	SRS	1.1.2	Passive Waste Tank Ventilators	0	400	500	25285	30420
48	663	Hanford	1.1.1.1	NDE for Hanford Waste Tanks	0	200	150	25285	30620
49	664	Hanford	1.2.1.6	Criticality Basis	0	300	350	25285	30920
50	683	Hanford	1.2.1.6	Tank Evaporation Monitoring	0	250	300	25285	31170
51	651	Idaho	1.3.1	Idaho V-Tank Remediation	0	1000	1500	25285	32170
52	616	SRS	1.2.1.4	Unplug Waste Transfer Lines	0	450	650	25285	32620
53	631	SRS	1.2.3.2.3	DWPF REDOX Adjustment	0	200	400	25285	32820
54	658	Hanford	1.1.3.3	Tc-99 Analysis	0	300	300	25285	33120
55	679B	Hanford	1.2.2.4	Waste Conditioning for Transfer	0	900	900	25285	34020
56	642	Idaho	1.2.3.2.4	Silica Gel (Russian)	0	300	1000	25285	34320
57	667	Hanford	1.2.1.7	Hanford Cs/Sr Capsule Initiative	0	300	500	25285	34620
58	638	SRS	1.2.3.2.4	DWPF Canister Decontamination	0	25	150	25285	34645
59	605B	Oak Ridge	1.2.2.7	Sludge Processing for ORR	0	105	0	25285	34750
60	622	SRS	1.2.1.2	In-Tank Solids Size Reduction	0	1000	1200	25285	35750
61	624	SRS	1.2.3.2.4	DWPF Equipment Enhancements	0	50	100	25285	35800
62	628	SRS	1.2.2.8	High Hydroxide Process for ITP	0	105	0	25285	35905
63	678B	Hanford	1.2.2.7	Pilot-Scale Sludge Processing	0	945	900	25285	36850
64	680	Hanford	1.2.1.2	Sonic Probe for Waste Mobilization	0	200	200	25285	37050
65	681	Hanford	1.2.1.5	Tank Leak Detection and Mitigation	0	250	300	25285	37300
66	682	Hanford	1.2.1.3	Alternate Tank Mixing Systems	0	900	900	25285	38200
67	657	Hanford	1.1.3.3	Hot Cell Energetics Measurement	0	300	150	25285	38500
68	659	Hanford	1.1.3.3	Tank Waste Organics Analysis	0	250	0	25285	38750
69	665	Hanford	1.1.3.3	Hydraulic Properties of Tank Wastes	0	250	300	25285	39000
70	691	Hanford	1.3.2.2	In-Situ Testing of Glass Release	0	400	100	25285	39400

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Table B.3. Tanks Focus Ar

TFA Response #	TFA Priority #	TFA Technology Title	OST Technology ID#	FY98 Su
604	29	GAAT Tank Isolation	N/A	OR16WT
605A	26	Cesium Removal Demonstration	21	OR16WT
606	17	Borehole Miner and Fluidic Jets for OHF and BVEST	1499, 1511	OR16WT
607	3	Slurry Monitors	1490	TFA/CMS
608	15	Grout & Glass Waste Forms for ORR	82	OR17WT
609	9	SLS for Melton Valley Storage Tanks	350	OR16WT
610A	22	Waste Conditioning CPU	1510	OR16WT
610B	23	Pulse Air	1510	OR16WT
610C	30	Jet Pump	1510	OR16WT
612	4	GAAT Tank Closure	N/A	OR16WT
613	18	Heel Retrieval for SRS	N/A	SR16WT4
614	2	Salt Removal Systems	N/A	SR16WT4
616	52	Unplug Waste Transfer Lines	N/A	AEA
623, 666	1	Waste Loading Improvement for HAW Glass	2009	SR16WT3
629	20	Metal Filters for Waste Tank Ventilation	N/A	SR18WT2
632	16	OTE Deployment for SRS	20	OR16WT Industry P
633	31	DWPF Process and Pour Spout Enhancements (FIU)	N/A	SR16WT3
636	25	Level and Density Monitors	N/A	SR18WT2
637	42	Caustic Recovery and Recycle	885	Industry P
640	32	Advanced Calcination for Idaho	881	ID76WT4
643	10	CUF SLS for Idaho	350	ID76WT4
645	5	TRUEX/SREX for Idaho Pretreatment	347	ID76WT4
647	11	LAW Waste Form for Idaho (Grout)	82	ID77WT3
648	27	LDUA Deployment at Idaho	85, 810, 835	ID77WT2
649	19	Process for Idaho HAW Immobilization	2009	ID77WT3
662, 627	7	Corrosion Probe and Corrosion Inhibitor Monitoring	1492, 1985	RL08WT
670	24	ILAW Form Release Test	82	RL06WT
671	12	Studies of Saltcake Dissolution and Concentrate Reprecipitation	881	RL08WT
672	13	Control of Leachate Solids Formation	81	OR16WT
673	28	Parametric Studies of Hanford Sludge Washing	350	RL36WT
674	21	Variable Depth Fluidic Sampling and Analysis	2007	RL08WT
675	8	Waste Form Product Acceptance Testing	N/A	CH37WT
679	6	Hanford Tanks Initiative	2010, 2011, 2012	RL07WT
679A	14	Enhanced Sluicing Systems		RL36WT

Note: Other TFA documents may have referred to a "TFA Need#" or a "TFA Need ID." These terms are synonomous identification of TFA tasks.

FY98 Task Crosswalk

orting Technical Task Plans (TTPs)	Site Submitting Need	Site Need ID#	Site PBS#	Task End Date (FY)
C; RL36WT51-F	Oak Ridge	TK-10	OR-43203	1999
D	Oak Ridge	TK-11	OR-38105	1998
B; RL36WT51-D; AEA	Oak Ridge	TK-03	OR-43201	1999
Funding	Oak Ridge	TK-04	OR-43203	1998
A; SR16WT31-B	Oak Ridge	TK-06	OR-38108	1998
A	Oak Ridge	TK-05	OR-43203	1999
D; RL36WT51-G	Oak Ridge	TK-02	OR-43203	1999
D; RL36WT51-G	Oak Ridge	TK-02	OR-43203	1999
D; RL36WT51-G	Oak Ridge	TK-02	OR-43203	1999
A; RL36WT51-B	Oak Ridge	TK-09	OR-43203	2000
B; RL36WT51-E	SRS	SR-2001	SR-HL03	2000
A; RL36WT51-A	SRS	SR-2002	SR-HL03	2001
	SRS	SR-2004	SR-HL01, SR-HL02	2000
A; RL37WT31-A	SRS	SR-2011	SR-HL05	2000
C; Industry Programs	SRS	SR-2017	SR-HL01	2000
G; CH28WT41; SR16WT41-A; grams	SRS	SR-2020	SR-HL08	2000
C; SR16WT31-D	SRS	SR-2121	SR-HL05	1999
B; Industry Programs	SRS	SR-2024	SR-HL05	2000
grams; AEA	SRS	SR-2025	SR-HL08	2001
C	Idaho	ID-2.1.02	ID-HLW03	1999
B	Idaho	ID-2.1.04	ID-HLW03	1998
A	Idaho	ID-2.1.06	ID-HLW03	1999
A; RL37WT31-B; AEA	Idaho	ID-2.1.07	ID-HLW03	2000
RL36WT51-H	Idaho	ID-2.1.10	ID-HLW03	1999
B; RL37WT31-C; RL06WT31-A	Idaho	ID-2.1.08	ID-HLW03	2000
A; SR18WT21-A	Hanford	OP1	RL-TW03	2000
B	Hanford	PW5	RL-TW09	1999
A; OR16WT41-B; University Programs	Hanford	PW6	RL-TW05	1999
C	Hanford	PW7	RL-TW06	1999
A; AL16WT41-A; OR16WT41-E; AEA	Hanford	PW8	RL-TW06, RL-TW07	2000
A; AEA	Hanford	PW9	RL-TW06	2000
A; RL37WT31-D; Industry Programs	Hanford	PW10	RL-TW07	1999
	Hanford	Retr 1	RL-TW04	2001
C	Hanford	Retr 1	RL-TW04	2000

h the "TFA Response #" used in this table, which is the more correct

Problem Element Title: 1.1.1 Extend Tank Life

Problem Element Description

Tank integrity and corrosion avoidance are critical issues during both long-term storage of radioactive tank wastes and during retrieval of tank wastes. This problem element addresses methods to monitor the integrity of tanks and avoid corrosion of steel tanks to aid in early detection of tank problems that may lead to leakage, to minimize the potential for tank failure, and to reduce the costs of maintaining safe operating conditions.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #		TFA Response #	Site	Need Title/Description
Primary	OP1	662	Hanford	DST Corrosion Monitoring
	OP2	663	Hanford	Remote Inspection of High-Level Waste Tanks
	SR-2015	627	SRS	In-Tank Corrosion Probe Development
Secondary	169	169	INEEL	Develop "Fly-by" Nondestructive Inspection System
	586	586	Hanford	NDE of Single Shell Tanks

Problem Statement

Real time corrosion inhibitor and corrosion monitoring methods are needed to provide early detection of potential problems that may lead to leakage or structural failure. There is a need to perform nondestructive examination of tank walls to determine structural integrity. Current methods are limited to contact examinations and usually require a cleaned surface and coupling between the head and structure being inspected.

Non-Destructive Examination - INEEL and Hanford

In FY96, INEEL and Hanford both submitted needs (169 and 586, respectively) for NDE techniques for tank wall and floor inspection to determine structural integrity. Although INEEL did not resubmit this need in FY97, Hanford resubmitted the need as #663. The need to perform nondestructive examination of tank walls and/or floors supports structural integrity determinations, tank life expectancy estimations, and retrieval strategy development. Current methods are limited to contact examinations and usually require a cleaned surface and coupling between the head and

structure being inspected. This is very difficult in underground storage tanks and improved methods that allow inspection to be performed without direct contact or through liquids are needed. The knuckle region of tanks where the side walls and bottoms were joined by welding are believed to be primary sites for degradation and leakage to occur. This inspection must be performed remotely and provide quantitative data on tank structure needed to ensure safety of current tank configurations and evaluate side loading limits. Hanford specifically needs an NDE system for both SSTs ('96 and '97 needs) and DSTs ('97 need only) to support sluicing feasibility and life expectancy estimation. Systems that can be deployed using a remote device such as the LDUA or other similar robotic equipment is desired.

Corrosion and Corrosion Inhibitor Monitoring - SRS and Hanford

High-level liquid wastes at the SRS and Hanford are stored in carbon steel tanks that are susceptible to nitrate ion-induced corrosion cracking. This is prevented by monitoring and maintaining adequate nitrate, nitrite and hydroxide ion levels. Sensors that could monitor all three species would be optimal to reduce the costs of current baseline sampling and laboratory analysis methods, and to minimize the addition of inhibitor solution. Currently, inhibitor solution containing NO2 and OH is added in excess causing more liquid to be introduced into the tank taking up much needed tank space and adding to the volume of waste that must eventually be retrieved and processed. Therefore, an increase in available tank space as well as a reduction in cost corresponding to the reduction in volume of waste requiring future processing would result if a OH-/NO3- /NO2- monitor could be used to control addition of inhibitor solution.

In addition to improvements in monitoring corrosion inhibitor concentrations through development of sensor systems, SRS and Hanford both have need for improved real-time corrosion detection systems that can "fine tune" the amount of tank inhibitor needed and provide more rapid and less expensive methods to detect the corrosive characteristics of the tank wastes. A corrosion probe system that provides real-time indication of corrosion potential in HLW tanks at multiple levels or positions in the tank are needed to reduce the costs of chemical analysis and detection while providing data on tank conditions.

Path to Solution

- Develop and demonstrate through Industry Programs an LDUA-delivered end effector for non-destructive examination inspection of Hanford's waste tanks.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
85, 810, 835	ID-HLW03	Light-Duty Utility Arm (LDUA)	Implementation
N/A	RL-TW-03	NDE End Effector (Oceaneering)	Demonstration
N/A		Stereo Camera End Effector	Implementation

- Identify, adapt, and evaluate monitors for NO3-/NO2-/OH- species to maintain corrosion inhibitor concentrations at SRS.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
1492	SR-HL01/02	Raman Sensor for NO3/NO2/OH (EIC)	Engineering Development

- Demonstrate and deploy the electrochemical corrosion probe at Hanford and transfer for demonstration and deployment at SRS.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
		Electrochemical Noise Corrosion Probe	Engineering Development

FY98-FY00 Scope and Schedule

Non-Destructive Examination - Work activities to support Hanford's need for tank integrity detection will include

- Investigate the status and capability of the LDUA NDE method and camera end effector to provide data on SST integrity.
  - Rad harden Oceaneering NDE system to support tank deployment (FY98, FETC Industry Programs).
  - Develop deployment plan and select tank(s) for initial deployment of LDUA-NDE system (FY98, EM-30).
- Assuming current Oceaneering system meets requirements, deploy LDUA and NDE/camera in a Hanford identified waste tank(s).
  - Cold test and evaluate integrated system to ensure performance requirements can be met (FY99, TFA & FETC Industry Programs).
  - Deploy LDUA-NDE/Camera system in selected Hanford Tank (FY99, TFA, EM-30, FETC Industry Programs).
- Develop decision logic to evaluate tank leakage potential from tank integrity data.
  - Using data obtained from the NDE and camera along with data from other sources such as; past leakage history, history of waste types in the tank, information from dry well around the tank, and records on corrosion inhibitor additions, develop a decision logic to evaluate potential for leakage in terms of tank integrity data (FY00, TFA & EM-30).
  - Develop strategy for retrieval system selection based on potential for leakage. Reevaluate the selection method in terms of sensitivity to input information and redefine the analysis method if necessary. Document the method and ensure that technology issues are addressed, safety issues are resolved, and operational issues are addressed (FY00, TFA & EM-30).

Corrosion and Corrosion Inhibitor Monitoring - Work activities to support Hanford and SRS needs will include

- Develop and demonstrate commercial Raman-based sensor system for NO3/NO2/OH detection to support SRS.
  - Develop Raman-based NO3/NO2 probe for SRS waste tank applications (FY98, TFA & CMST). Decision point for demonstration.
  - Evaluate and design hydroxide measurement techniques for chemistry probes (FY99, TFA & Characterization, Monitoring, and Sensor Technology [CMST]).
  - Demonstrate NO3/NO2/OH chemistry probe in hot cell environment with tank waste samples (FY99, TFA & CMST). Decision point for implementation.
  - Deploy NO3/NO2/OH probe in selected waste tank at SRS (FY00).
- Demonstrate first generation Electrochemical Noise (EN) corrosion probe in Hanford Tanks and develop second generation probe for implementation.
  - Demonstrate first generation EN probe in Hanford waste tanks (FY97, TFA & EM-30).
  - Complete development and demonstration of second generation EN prototype probe (FY98,

TFA & EM-30). Decision point for initial implementation.
  - Develop production model corrosion probe (FY99, TFA & EM-30).
  - Develop final hardware/software system for probe data analysis and deploy production probes in five Hanford HLW Tanks (FY00, TFA & EM-30).
- Test and evaluate EN Corrosion probe for SRS application and transfer for deployment.
  - Complete evaluation of EN corrosion probe with SRS simulated tank wastes to develop relationship of corrosion conditions to probe signal (FY98, TFA). Decision point for demonstration.
  - Design, develop, and demonstrate prototype EN probe for SRS application (FY99, TFA & EM30). Decision point for implementation.
  - Deploy EN Corrosion probe in SRS HLW tank and evaluate performance (FY00, TFA & EM-30).

Other Related Work

- Nitrate/Nitrite/Hydroxide Monitor (CMST: FY98, $197K)
- NDE for Hanford Waste Tanks (Industry Programs: FY98, $400K; FY99, $425K)
- Development of Advanced Electrochemical Emission Spectroscopy for Monitoring Corrosion in Simulated DOE Liquid Waste (EMSP: FY97, Pennsylvania State University, $350K)
- Mechanism of Pitting Corrosion Prevention by Nitrite in Carbon Steel Exposed to Dilute Salt Solutions (EMSP: FY97, Westinghouse Savannah River Company, $650K)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	395	750	450
EM-50 Crosscut Programs	197		
EM-50 Industry/University/International	400	425	
EM-30/40	75		
Total	1067	1175	450

Problem Element Title: 1.1.2 Ventilate Tanks

Problem Element Description

Waste tank ventilation is necessary to maintain safe operating conditions within the tank farm. Ventilation systems prevent exposure of workers to highly radioactive aerosols and particulate that are generated within the waste tanks during waste decay, mixing, and transfer. Methods for active and passive waste ventilation and filtration are encompassed within this problem element.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary". These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary SR-2017	629	SRS	Demonstrate Use of Sintered Metal Filters in place of HEPA Filters and Paper Filters on Air Sampling Systems
SR-2013	625	SRS	Passive Waste Tank Ventilators

Problem Statement

Waste tank ventilation is necessary to maintain safe operating conditions within the tank farm. However, baseline ventilation systems are comprised of energy- and maintenance-intensive components. For example, frequent change-out of disposable HEPA filters increases the cost and risk of maintaining safe tank operations.

Improvements in Filtration

HEPA filters are used throughout the SRS complex to ensure that air emissions to the environment are free of radioactive particulates. Filters are generally constructed of a 0.013-inch-thick glass fiber material and must meet the industry standard for 99.97% capture of 0.3 micrometer diameter aerosol particles. Typical of the filters in use at SRS is the Flanders Super-Flow® II type GG-F filter. It is constructed of "fan folded" borosilicate glass fiber paper. HEPA filters in service at SRS waste management (e.g., SRS H and F Tank Farms) have the following typical attributes:

- Two year average life (limited by filter media failure)
- Replaced when any of the following conditions are exceeded
  - Pressure drop exceeds 6" wc
  - Gamma radiation becomes excessive (due to collected particles)
  - Fails 99.97% DOP test

Water is the principal problem encountered with existing HEPAs. Preheaters are installed in the air

ducts upstream of most waste management HEPAs in an effort to prevent condensation and subsequent damage to the HEPA. The need exists to eliminate costly failure problems associated with wetting of the filter, and provide an improved filter whose design includes permanently installed spray wash nozzles, which would be used to restore flow to a plugged or partially plugged filter. For example, use of a HEPA filter constructed of sintered stainless steel will provide filtration that is not subject to water damage, and can be installed with built-in water jets which will be used to wash the filter to reduce radiation and to eliminate dirt accumulation.

Passive Ventilation

A primary cost of HLW tank ventilation, in addition to filter changeout and replacement, is operation and maintenance costs associated with the active ventilation system (i.e., blowers, condensers, demisters, heaters, and the HEPA filters). In addition, upgrades to existing systems require significant capital investment. SRS is interested in alternatives to the active ventilation systems. For example, a passive device that ventilates the waste tank interior is needed. A tank top device is needed to purge the waste tank atmosphere of accumulated hydrogen gas and organic vapor. This type of system would need to provide a HEPA barrier between the tank atmosphere and the environment and provide an air exchange for a filled waste tank air space every 9 days (approximately 16,000 cubic foot volume).

Path to Solution

- Design and procure regenerable (i.e., washable) sintered metal filter systems to replace HEPA filters within tank ventilation systems at SRS to reduce worker risk and cost.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	SR-HL02	Sintered Metal Filters for Ventilation	Engineering Development

- Design, select, and demonstrate passive ventilation systems to reduce the O&M costs of active ventilation systems at SRS.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	SR-HL01/02	Passive Ventilation for HLW Tanks	Advanced Development

FY98-FY00 Scope and Schedule

Filtration - Work activities to support SRS's need for improved tank ventilation filtration will include

- Develop performance specifications and initiate an industrial contract through Industry Programs for metal filter technology.
  - Develop specification through review of the metal filter technology conducted to date and configuration requirements for SRS tanks (FY98, TFA, EM-30, FETC).
  - Issue industry call for proposals (RFP), review, and select proposer for design, testing, and fabrication of a metal filter ventilation system for SRS tanks (FY98, FETC , TFA, EM-30).
- Design and fabrication prototype filtration system, select SRS tank(s) for initial testing and demonstration, monitor and support technical progress on development of filtration system.
  - Develop system designs and select final design for fabrication of prototype filtration system for testing at SRS (FY99, FETC).
  - Review contractor-generated designs and support decision on final filtration system

configuration (FY99, TFA & EM-30). Decision point for demonstration. Note: Gate date is 9/98 rather than 99. Depends on procurement schedule and proposers' responsiveness.
  - Develop testing plan and system acceptance testing procedures. Select tanks for demonstration and deployment of first filtration systems (FY99, TFA & EM-30).
- Demonstrate and deploy filtration system on SRS HLW tank.
  - Deliver filtration system to SRS for acceptance testing (FY00, FETC).
  - Complete verification and final hardware design and fabrication for tank interface (FY00, TFA & EM-30).
  - Demonstrate and deploy filtration system on a SRS HLW tank and evaluate performance data (FY00, TFA & EM-30).

Passive Ventilation

- Procure passive ventilation system designs from Industry.
  - Develop performance specifications and issue an industrial RFP to solicit passive ventilation system designs (FY98, TFA, EM-30, FETC).
  - Perform a technical evaluation and downselect to one or two designs for development of passive ventilation system prototypes for testing (FY99, TFA, EM-30, FETC).
- Test and Demonstrate preferred prototype systems.
  - Develop prototype passive ventilation systems, perform safety analysis, and develop operations requirements and installation procedures (FY99, TFA, EM-30, FETC).
  - Construct and demonstrate the passive ventilation systems. Depending on safety requirements, cold test systems prior to hot testing in HLW tanks (FY99, TFA, EM-30, FETC).
- Complete initial deployment of a passive ventilation system on selected HLW tank.
  - Collect data and analyses to support necessary design changes for full-scale implementation (FY00, EM-30, TFA).
  - Procure, construct, and deploy a final design unit (FY00, EM-30).

Other Related Work

- Metal Filters for Waste Tank Ventilation (Industry Programs: FY98, $500K; FY99, $325K)
- Passive Waste Tank Ventilators (Industry Programs: FY99, $800K; FY00, $1075K)
- Washable Metal HEPA Filters (Technology Deployment Initiative: FY97, Idaho Operations Office)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	50	600	600
EM-50 Crosscut Programs			
EM-50 Industry/University/International	500	1125	1075
EM-30/40			
Total	550	1725	1675

Problem Element Title: 1.1.3 Characterize Waste

Problem Element Description

The baseline method for characterization of tank wastes is to collect waste samples and perform laboratory analyses in a hot cell. Improvements in sample collection methods, especially off-riser, hot cell analytical methods, and in-situ characterization methods are needed to expedite and reduce the costs of tank waste characterization. In-tank or in situ characterization is highly desired as it could provide more rapid and cost-effective waste analysis. Characterization of tank waste physical, chemical, and radiochemical properties is required for planning and implementation of tank safety, retrieval, pretreatment, immobilization, and closure processes.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary TK-01	611	ORR	Oak Ridge National Laboratory Tank Waste Characterization
SR-2003	615	SRS	In Situ Methods for Characterization of Tank Wastes
Char 3	657	Hanford	Large Sample Hot Cell DSC/TGA Based Energentics Measurement
Char 4	658	Hanford	Technetium-99 Analysis in Low-Level Waste Feed
Char 5	659	Hanford	Rapid Speciation of Organic Acids and Complexants
Saf 2	665	Hanford	Safety Related Transport Properties of Fuel-Rich Organics

Problem Statement

In Situ Characterization

In situ characterization methods are needed to support retrieval operations and waste pretreatment. Designing and deploying effective waste retrieval systems for tank wastes requires knowledge of the waste characteristics, such as the volumes and interface between supernate, sludge, and/or hard heel. Methods to map the sludge or heel level are needed for tanks where the bulk supernate remains, to allow for design of the retrieval system and retrieval strategy prior to supernate removal. Specifically, ORR needs a sludge mapping system to measure the volume of sludge under the supernate before and after removal to assess vendor performance.

Chemical characterization through in situ sensing is also needed to support pretreatment operations. For example, SRS needs in situ methods for monitoring sodium and potassium levels during the in-tank precipitation process for cesium removal.

Analysis of Wastes

Tank waste analysis methods are needed at Hanford to support safe waste storage, waste transfer operations, and feed identification for privatization. Waste samples must be collected and undergo analysis in hot cells. Analytical instruments and/or methods are needed for measurement of a) energetics, b) organics, c) hydraulic properties, and d) Tc concentrations to support safety evaluations and privatization feed decisions.

- Energetics: An instrument is required to estimate the energetics of complex chemical mixtures obtained by sampling Hanford waste tanks. The energetics of wastes when dried is one measure of safety during storage of wastes in Hanford single-shell tanks. Present methods, using milligram aliquots of waste samples, waste samples may not provide representative sampling for such safety decisions. The instrumentation needs to be deployable in a hot cell and be capable of measuring energetics (DSC) and moisture (TGA) over the ambient-to-500°C range on high-level waste samples.

- Organics: A rapid laboratory method for quantification of major organic constituents in Hanford tank wastes is needed to estimate flammability, fuel content, and complexing capacity. Total organic carbon analyses frequently indicate single-shell and double-shell tanks have high levels of organic material present. At least 80 percent of the total organic content needs to be identified with compounds for evaluation of waste classification as "safe," "conditionally safe," or "unsafe."

- Hydraulic Properties: Characterization of waste hydraulic properties is needed, in support of Organic Safety Issue and Continued Tank Farm Operations (e.g., salt-well pumping), to predict the long-term distribution of moisture and soluble chemical species in stabilized single shell tanks, which must be maintained in safe conditions until the contained radionuclides can be processed into a safer storage system. Measurements of waste hydraulic properties such as permeability and capillary liquid retention are needed in modern numerical fluid flow simulators, which can be used to predict the potential drying of waste and the possible redistribution of soluble chemicals within a waste. Constitutive models of waste that connect the measurements of a waste's hydraulic properties to chemical characteristics and grain-size information are needed. Better estimates of hydraulic properties can also help assess through modeling the effectiveness of pumping tanks that are not yet stabilized.

- Tc-99 Analysis: An accurate production laboratory method for establishing the technetium-99 concentration in LLW and vadose zone soils is needed. Technetium-99 concentration is a critical component of feed to the waste vitrification vendors. The absolute accuracy of these analytical results produced at Hanford has been questioned and found to be in disagreement with results produced at another DOE site. Variability of redox potential and interferences present in Hanford tank wastes produces inconsistent performance of sample preparation methods in use. In addition, the method must be applicable to soils which may receive waste material that leak from the tank. Technetium in the +7 oxidation state is known to be mobile in the soil column and therefore the concentration in tank wastes must be known well to estimate long term effects of waste tank leakage during storage or retrieval operations.

Problem Element Title: 1.1.3 Characterize Waste

Path to Solution

- Develop and demonstrate a sludge mapping tool to measure the volume of sludge present in tanks prior to and after supernate retrieval at ORR.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	OR-43203	Sludge Mapping Tool	Engineering Development

- Develop Na/K monitor for in-tank measurement of ion concentrations to support in-tank precipitation process at SRS

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	SR-HL01/02	In Situ Na/K Monitor	Engineering Development

- Procure and adapt analysis methods, instrumentation, and data to support resolution of safety issues associated with Hanford waste energetics, organics content, and hydraulic properties.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	N/A	Hot Cell DSC/TGA Analyzer	Engineering Development
N/A	RL-TW01	Organics Analyzer	Implementation

- Conduct round robin test of Tc-99 analytical methods to develop confidence in techniques to support Hanford privatization feed preparations.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	RL-TW01	Tc-99 Analysis	Demonstration

FY98-FY00 Scope and Schedule

In Situ Characterization

Sludge Mapping Tools - Work activities to support ORR's need for sludge mapping tools will include

- Define requirements and identify deployment method for sludge mapping.
  - Define functions and requirements and identify deployment platform and mapping equipment for Melton Valley Storage Tank (MVST) sludge mapping (FY99, TFA). Decision point for procurement and demonstration.
  - Initiate procurement, fabrication of system components, and cold testing of components (FY99, TFA).
- Assemble components, test, and deploy system for sludge level measurements at ORR.
  - Complete mapping system assembly, calibration, and cold testing (FY00, TFA).
  - Initiate in-tank deployment at MVST (FY00, TFA).

In-Tank Sodium/Potassium Monitor - Work activities to support SRS's need for in situ characterization of sodium and potassium concentrations will include

- Define specifications, functions, and requirements (F&R) for in-tank Na/K ion monitor.
  - Define sensor concentration range, accuracy, precision, calibration procedure, service life, safety concerns, materials of construction, deployment platform, hardware, etc. to support procurement and comparison of sensors (FY99, TFA).
  - Conduct feasibility evaluation of candidate analyzers best suited for application based on F&R. Procure one or more sensors for laboratory testing. Conduct cold surrogate tests (FY99, TFA).
- Downselect sensor and deploy in-tank.
  - Complete laboratory tests and downselect sensor. Procure new or modify existing sensor for deployment (FY00, TFA).
  - Fabricate deployment platform and deploy sensor. Collect data to demonstrate performance in hot environment (FY00, TFA & EM-30).

Analysis of Wastes - Work activities to support Hanford's needs for improved analysis of waste will include

Energetics Measurement

- Develop functions and requirements and procure modified commercial DSC/TGA analyzer.
  - Determine design and performance specifications for a 500 mg capacity DSC/TGA to include capability for handling and analyzing samples remotely in a hot cell.
  - Conduct vendor survey and procure a modified commercial DSC/TGA.
- Test commercial analysis system and prepare for hot cell deployment.
  - Conduct Laboratory tests with standard and surrogate materials to verify performance of instrument. Determine logistics of procedure for remote application (FY99, TFA).
  - Design and fabricate supporting hardware for installation of sensor compartment in a hot-cell and associated electronics outside of hot-cell (FY99, TFA & EM-30).
  - Make required hot-cell modification to accommodate the DSC/TGA. Install DSC/TGA sensor module and supporting hardware into hot-cell (FY00, TFA & EM-30).
- Deploy DSC/TGA in Hanford hot cell and verify performance.
  - Verify operational readiness with surrogate materials (FY00, TFA & EM-30).
  - Validate operation by conducting DSC/TGA analysis on about 20 actual HLW samples (FY00, TFA & EM-30).

Organics Analysis

- Downselect method and instrumentation and optimize procedures.
  - Downselect sample pretreatment steps and instrumentation for rapid analysis of organic species in tank waste, based on preliminary testing conducted in FY97 using EM-30 support (FY99, TFA & EM-30).
  - Optimize analytical procedures and validate performance of selected method on actual tank waste samples. Issue report on procedures and analytical accuracy and precision (FY99, TFA & EM-30).

Hydraulic Properties

- Identify numerical approach and experimental program needs.
  - Review state-of-the-art numerical methods/constitutive models having the capability to calculate the interstitial liquid distribution (FY99, TFA).
  - Evaluate potential experimental configurations and data needs (FY99, TFA).

- Develop experimental data to calibrate and evaluate numerical methods.
  - Evaluate permeability and capillary data and numerical methods to further define needs. Evaluate the possibility for bounding calculations that could reduce the data needs (FY00, TFA).
  - Predict hydraulic properties of a known waste type and evaluate the prediction using experimental information (FY00, TFA).
  - Deploy the numerical methods to predict several waste tank interstitial liquid distributions and compare the prediction with criteria to mitigate exothermic reactions (FY01, TFA & EM-30).

Tc-99 Analysis

- Conduct round-robin testing of standards and unknown surrogates to check for operational readiness of procedures on hot samples.
  - Enlist several contractors and possibly private laboratories to participate in round-robin testing with agreement on sample pretreatment, analytical protocol, and data reduction format for each proposed production laboratory Tc-99 method. Establish lead laboratory to prepare standard and unknown samples for analysis (FY99, TFA).
  - Conduct round-robin testing of standards and unknown surrogates (except to lead lab) to check for operational readiness of procedures on hot samples (FY99, TFA).
- Conduct round-robin testing of hot LLW samples.
  - Conduct testing with hot LLW samples with unknown amounts of Tc-99 with periodic comparative checks using standards. Determine reason for variance in Tc-99 results among the labs (FY00, TFA).
  - Recommend best sample pretreatment and analytical methods vs. type sample for Tc-99 analysis and issue report (FY00, TFA).

Other Related Work

- The Nox System in Nuclear Waste (EMSP: FY96, Argonne National Laboratory)
- Imaging and Characterizing the Waste Materials Inside an Underground Storage Tank Using Seismic Normal Modes (EMSP: FY96, Massachusetts Institute of Technology)
- Studies Related to Chemical Mechanisms of Gas Formation in Hanford High-Level Nuclear Wastes (EMSP: FY96, Georgia Institute of Technology)
- Microstructural Properties of High Level Waste Concentrates and Gels with Raman and Infrared Spectroscopies (EMSP: FY96, Los Alamos National Laboratory)
- Interfacial Radiolysis Effects in Tank Waste Speciation (EMSP: FY96, Pacific Northwest National Laboratory)
- Design and Development of a New Hybrid Spectroelectrochemical Sensor (EMSP: FY96, University of Cincinnati)
- High Temperature Condensed Phase Mass Spectrometric Analysis (EMSP: FY97, Idaho National Engineering and Environmental Laboratory, $680K)
- Reactivity of Peroxynitrite: Implications for Hanford Waste Management and Remediation (EMSP: FY97, Brookhaven National Laboratory, $700K)
- Optically-Based Array Sensors for Selective In Situ Analysis of Tank Waste (EMSP: FY97, Oak Ridge National Laboratory, $600K)
- Thermospray Mass Spectrometry Ionization Processes Fundamental Mechanisms for Speciation, Separation and Characterization of Organic Complexants in DOE Wastes (EMSP: FY97, Oak Ridge National Laboratory, $590K)
- Mechanics of Bubbles in Sludges and Slurries (EMSP: FY97, Pacific Northwest National Laboratory, $1,132K)

Problem Element Title 1.1.3 Characterize Waste

- Particle Generation by Laser Ablation in Support of Chemical Analysis of High Level Mixed Waste from Plutonium Production Operations (Technology Deployment Inititative: FY97, Washington State University, $544K)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA		1850	1450
EM-50 Crosscut Programs			
EM-50 Industry/University/International			
EM-30/40			
Total		1850	1450

Problem Element Title 1.1.4. Reduce Waste Volumes

Problem Element Description

Secondary wastes such as contaminated water from offgas treatment systems are generated during the processing of tank wastes. Some of these streams are currently recycled to the tank farms due to their composition and lack of treatment trains that could allow release to liquid effluent treatment plants. Treatment of these waste streams would free tank storage spare and reduce life-cycle cost by reducing the volume of waste re-entering process plants.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary SR-2007	619	SRS	Provide Alternative Processing and/or Concentration Methods for DWPF Recycle Aqueous Streams
ID-2.1.01	639	INEEL	Reduction in Liquid HLW

Problem Statement

Tank farms are still receiving wastes even though many major mission operations have ceased at most of the sites. Some of these wastes result from decontamination and decommissioning (D&D) operations, from tank-to-tank transfers to solve waste storage problems, or from tank waste processing operations.

At SRS, the recycle stream from the Defense Waste Processing Facility (DWPF) is adding to the volume of tank waste requiring subsequent treatment. Removal of dilute concentrations of problem constituents from this stream, such as cesium, solids, and mercury could allow these wastes to be discharged rather than being recycled to the tank farms for subsequent costly processing. The DWPF recycle stream must be processed in such a manner that approximately 95% of the stream is decontaminated so that it can be processed by the Effluent Treatment Facility. The remaining 5% would be transferred to the high level waste tank farm.

At the INEEL, the Idaho Chemical Processing Plant (ICPP) generates radioactive liquid waste from D&D operations, which is routed to the tank farm. The liquid waste ranges from slightly contaminated water to highly radioactive waste containing many hazardous components. Current technologies used for D&D include chemical cleaning, CO_2 pellet blasting, liquid abrasive blasting,

mechanical scabbling, and strippable coatings. Improved D&D methods that reduce the volume of liquid waste generated are needed. Examples of improved methods include laser ablation and ultra high liquid nitrogen.

Path to Solution

- Develop specifications, procure, and adapt a commercial system, and demonstrate the compact processing unit for the DWPF recycle stream.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
239	SR-HL04	CSTs CPU	Implementation
N/A	N/A	Hg Removal	Demonstration
350	N/A	Solid-Liquid Separation (SLS) Cells Unit Filter (CUF)	Implemenation

- Adapt, demonstrate, and deploy a laser ablation decontamination system for ICPP D&D water volume reduction at INEEL.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	N/a	Laser Ablation Decontamination	Demonstration

FY98-FY00 Scope and Schedule

Crystalline-Silico Titanates (CSTs) for SRS's DWPF Recycle Stream

- Develop specifications for an industry RFP to design an integrated treatment unit for SRS.
  - Complete specifications and issue RFP for Phase I conceptual design. Build off of past and ongoing EM-50 efforts with CSTs, Hg removal, and solid-liquid separation (FY98, TFA, EM-30, and FETC Industry Programs).
  - Select industrial contractor for conceptual design stage (FY98, TFA and FETC Industry Programs).
- Complete conceptual design of compact processing unit (CPU).
  - Evaluate conceptual designs relative to performance requirements (FY99, TFA, EM-30, FETC Industry Programs). Decision point for Phase II fabrication (demonstration).
  - Conduct confirmatory bench-scale testing to ensure conceptual system meets performance requirements (FY99, TFA, EM-30).
- Deliver, demonstrate, and deploy CPU for DWPF recycle stream.
  - Deliver CPU for shakedown testing (FY00, FETC Industry Programs).
  - Demonstrate and deploy CPU on SRS DWPF recycle stream (FY00, TFA, EM-30).
  - Deploy CPU for waste stream volume reduction (FY01, EM-30).

Low Water Decontamination System for INEEL's ICPP

- Develop fieldable laser ablation decontamination system for ICPP testing.
  - Develop a fieldable laser-ablation decontamination system based on available laboratory model (FY99, TFA & EM-30).
  - Develop functions and requirements for the needed performance of waste water/ decontamination systems (FY99, TFA & EM-30).
- Complete initial hot deployment and performance evaluation.

- Demonstrate laser-ablation decontamination system on hot wastes at INEEL. Evaluate performance of system and issue recommendations based on systems analysis and generated functions and requirements (FY00, TFA & EM-30).
- Deploy decontamination system within ICPP for volume reduction (FY01, EM-30).

Other Related Work

- Advanced Chemical Separations at SRS (Efficient Separations and Processing (ESP) SR16C342, FY98, $125K)
- CSTs for DWPF Recycle Streams (Industry Programs, FY99, $500K; FY99, $500K; FY00, $525K)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA		925	1075
EM-50 Crosscut Programs	125		
EM-50 Industry/University/International		500	525
EM-30/40			
Total	125	1425	1600

Problem Element Title: 1.2.1.2 Mobilize Bulk and Heel Wastes

Problem Element Description

Mobilizing bulk and heel wastes within a tank is required to remove materials for tank closure, for treatment, and for ultimate immobilization and disposal of the hazardous waste components. Mobilizing dense sludge, saltcake, and dry/hardened materials is particularly challenging and important for retrieval operations. Baseline methods for waste mobilization are mixer pumps and long-range, high water volume sluicing.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary SR-2001	613	SRS	Tank Heel Removal
SR-2002	614	SRS	Alternative Salt Removal Techniques
SR-2005	617	SRS	Annulus Space Cleaning
SR-2010	622	SRS	Solids Size Reduction in Waste Tanks
Retr-1	679A	Hanford	SST Retrieval Equipment/System Development
Retr 1	679	Hanford	Establish Retrieval Performance Evaluation Criteria
SR-2009	621	SRS	Enhanced Chemical Cleaning Methods for High Level Waste Tank Closure
TK-02	610	ORR	Oak Ridge National Laboratory Tank Solid Waste Removal
TK-03	606	ORR	Oak Ridge National Laboratory Sludge Mixing and Mobilization
Secondary Retr-2	680	Hanford	Initial Waste Mobilization Methods Needed to Enhance Advanced Design Mixer Pump Retrieval for DST Waste Not Affected by Existing Mixing Pump Performance

Problem Statement

The DOE complex has horizontal and vertical cylindrical steel and concrete waste storage tanks that require remediation. Removal of bulk saltcake and sludge, saltcake heels, hard sludge heels, and debris will be required. Alternative approaches to the hydraulic mining baseline are required for retrieval of the hard sludges, and residual waste too heavy to be removed by conventional slurry techniques, or bulk waste retrieval in leaking tanks where water use is restricted, as well as removal

of debris and contaminated floor and wall segments. There is also a need for technical support for producing functions and requirements documents and prototypic hardware to allow sites to procure the right equipment. This includes bringing in data and lessons learned from similar activities from across the DOE complex.

Sludge Mixing, Mobilization, and Retrieval for ORR

Sludge and heel retrieval from ORR's horizontal steel tanks and vertical concrete (i.e., gunite) tanks is required for tank remediation and closure. Dislodging, mobilization, transfer, and waste conditioning systems (also see problem elements 1.2.1.4 Transfer Waste and 1.2.2.3 Prepare Retrieved Waste for Transfer and Pretreatment) are needed to remove bulk quantities of sludge from the tanks.

ORNL has horizontal 50,000-gal stainless steel underground storage tanks, which have limited access and internal obstructions (Bethel Valley Evaporator Service Tanks [BVEST]) and horizontal 13,000 - 25,000-gal carbon steel tanks (Old Hydrofracture Tanks [OHF]). The BVEST will remain in service and the OHF tanks will be remediated after the sludges are retrieved for treatment and disposal.

ORNL also has 50-year old vertical concrete tanks. The first tanks to be remediated are unlined gunite tanks. These tanks contain transuranic (TRU) and non-TRU wastes. The sludge ranges from very soft silt texture to blocks as hard as concrete. A small amount of debris, hardware, spalled concrete, and chunks of concrete inside the tanks also need to be retrieved.

Saltcake, Bulk Sludge, Heel, and Debris Retrieval for SRS

Saltcake is formed through successive evaporation cycles of alkali waste and must be redissolved and transferred to the In-Tank Precipitation (ITP) Facility for further processing. Traditional salt and bulk sludge removal involves installing large slurry pumps into the tank to vigorously mix the contents into solution. However, it costs approximately $6-10 million dollars per tank to perform salt or sludge removal on a waste tank using the slurry pump method. Less cost intensive and invasive methods to re-dissolve the salt, such as modified density gradient or water jets, are desired.

Residual heels of sludge and debris remain on the bottoms of the waste tanks after bulk waste removal is performed. The types of debris and residual waste include the following - hardened sludge - heavy, possible cohesive sludge deposits - zeolite - silica - reel tapes, and clinkers. Conventional waste removal techniques utilizing slurry pumps and transfer jets/pumps do not suspend and remove these types of waste. As much as 40,000 gallons of residue can remain after a conventional waste removal campaign. Methods must be explored and developed to successfully remove these heels. Tank closure is not possible unless much of this residue is removed. For example, Tank 19 is scheduled for closure during FY98; however, a 25,000 gallon (estimated) residual zeolite heel remains which prevents immediate closure activities. In addition to residual heels, the Type I, II, and III waste storage tanks are also equipped with an annular space between the primary containment wall and the secondary containment wall. Waste has leaked in the tank annulus on several of these waste tanks. Before closing the tank for final disposition, waste from the annulus must be removed and the space cleaned. There are no proven methods of removing highly radioactive waste from this type of geometry.

Enhanced Sluicing and Waste Mobilization for Hanford

Performance and cost data comparing alternate and enhanced retrieval methods to the performance baseline of past-practice sluicing are needed for Hanford's single shell tanks. Data will be applied to

the selection of retrieval systems for 1)Tank C-106 Heel Removal (part of Hanford Tanks Initiative), 2) M&I retrieval of SSTs during Privatization Phase I (e.g., C-106 sluicing campaign) and Initial SST Retrieval System (ISSTRS), 3) concept design technical input to the Privatization Phase II specification (Tri-Party Agreement [TPA] Milestone M-45-04A) and 4) performance assessment for SST closure. Improvements to the baseline past practice sluicing are of immediate interest to support the C-106 bulk waste removal campaign and heel retrieval as part of the Hanford Tanks Initiative.

In addition to SSTs, retrieval of DSTs using the baseline of two mixer pumps is expected to leave a considerable amount of hard, heavy, and/or cohesive sludge heel. While this is adequate for initial HLW feed, the program needs assurance that if the effective cleaning radius of the mixers proves insufficient, that a backup method can be deployed to mobilize enough residual waste to complete the mission. Further effort in predicting the effective cleaning radius by characterizing the shear strength, or resistance to mobilization, of the sludge is needed to plan for use of a backup method. Alternative or supplementary methods are needed to better mobilize sludge from DSTs containing HLW feed for Phase I privatization. Other DSTs may contain hard heels and sludges and other waste types, waste which mixer pumps will not adequately mobilize.

Path to Solution

- Deploy pulsed air and improved jet pump systems to support ORR GAAT retrieval with the MLDUA, Houdini, and Confined Sluicing End Effector.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
1510	OR-43203	Jet Pump	Demonstration
1510	OR-43203	Pulsed Air	Demonstration

- Demonstrate fluidic pulse jets for sludge mobilization in ORR Bethel Valley Evaporator Service Tanks.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
1499	OR-43203	Fluidic Pulse Jets	Demonstration

- Design and deploy the extendible nozzle/borehole miner to support retrieval of sludges from the ORR Old Hydrofracture tanks.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
1499	OR-43203	Extendible Nozzle Borehole Miner	Demonstration

- Demonstrate and deploy salt dissolution methods for tank annuli and modified density gradient salt dissolution for bulk saltcake retrieval at SRS.

Problem Element Title: 1.2.1.2 Mobilize Bulk and Heel Wastes

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	N/A	Water Retrieval Device	Demonstration
1989	N/A	Modified Density Gradient Salt Dissolution	Demonstration

- Develop performance specifications and procure and test commercial systems for heel retrieval at SRS and Hanford.
- Test and demonstrate chemical cleaning methods for final retrieval of tank residuals prior to tank closure at SRS.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	N/A	Chemical Tank Cleaning	Demonstration

- Evaluate improvements to Hanford past-practice sluicing and demonstrate industry capability for heel retrieval to support SST retrieval efforts at Hanford.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	RL-TW04	Enhanced Sluicing	Engineering Development
N/A	N/A	Commercial Retrieval Systems	Demonstration

- Incorporate retrieval systems' performance data and lessons learned into the retrieval analysis tool to support site decision making.

FY98-FY00 Scope and Schedule

Sludge Mixing, Mobilization, and Retrieval for ORR - Work activities to support ORR's needs for sludge mixing, mobilization, and retrieval include

Gunite and Associated Tanks Retrieval

- Develop and deploy improved jet pump to support GAAT retrieval.
  - Complete specifications for improved jet pump to reduce wear and optimize performance for both two and three phase flow regimes. Fabricate jet pump (FY98, TFA & EM-40).
  - Verify improved jet pump performance and deliver to ORR for deployment during GAAT retrieval campaign (FY98, TFA & EM-40). Decision point for implementation.
  - Deploy improved jet pump to support GAAT retrieval (FY98, TFA & EM-40)
- Deploy pulsed air system to maintain sludge suspension for transfer.
  - Deliver pulsed air system designed for ORR tank W-9 application (FY98, TFA & EM-40)
  - Demonstrate pulsed air system performance in W-9 to support continued operation and deployment (FY99, TFA & EM-40). Decision point for implementation.

Bethel Valley Evaporator Service Tanks (BVEST) Sludge Mobilization and Retrieval

- Demonstrate AEA Fluidic Pulse Jets for sludge mobilization.
  - Demonstrate fluidic pulse jets for mobilization of BVEST sludges to support transfer to Melton Valley (FY98, EM-30 & EM-50 International Programs).
  - Complete performance assessment of AEAT fluidic pulse jet mixers (FY98, TFA & EM-30).

Decision point for implementation.
- Deploy fluidic pulse jets for BVEST retrieval operations (FY99, EM-30).

OHF Tanks Sludge Retrieval
- Test and demonstrate Bore Hole Miner for sludge mobilization in OHF tanks.
  - Complete cold test of extendible nozzle Bore Hole Miner, evaluate performance, and identify deficiencies and readiness to deploy (FY98, TFA & EM-30). Decision point for demonstration.
  - Complete initial hot demonstration of extendible nozzle Bore Hole Miner and evaluate performance on waste mobilization and transport of the system to subsequent tanks (FY98, TFA & EM-30). Decision point on implementation.
  - Complete deployment of extendible nozzle at OHF tanks and provide performance assessment data to support future site applications (FY99, EM-30).

Saltcake, Heel, and Debris Retrieval for SRS - Work activities to support SRS's needs for saltcake, annulus salt, heel and clinker retrieval, and chemical cleaning include
Saltcake Retrieval
- Adapt and demonstrate salt retrieval device for salt dissolution.
  - Assemble, cold test, and complete initial hot testing of salt retrieval device (FY98, TFA & EM-30).
  - Demonstrate retrieval device in Tank 16 Annulus at SRS (FY98, TFA & EM-30). Decision point for implementation.
- Demonstrate modified density gradient technique for salt retrieval.
  - Develop test plan and schedule integrating salt retrieval demonstration into site baseline schedule (FY99, TFA & EM-30).
  - Initiate demonstration and deployment of density gradient salt retrieval for Tank 25 or 41 (FY99, TFA & EM-30). Decision point for implementation.
  - Initiate deployment of density gradient salt retrieval for Tank 29 (FY01, EM-30).

Heel Retrieval
- Develop and demonstrate technology for heel retrieval from Type IV tanks.
  - Develop functional requirements and plan for heel retrieval from Type IV tanks (FY98, TFA & EM-30).
  - Procure, assemble, and test heel retrieval equipment (FY98, TFA & EM-30). Decision point for implementation.
- Procure and Demonstrate Heel Retrieval from Type I and II tanks.
  - Develop functional requirements for heel retrieval from Type I and II tanks (FY99, TFA & EM-30).
  - Procure, assemble and test heel retrieval equipment (FY99, TFA & EM-30). Decision point for implementation.
  - Complete demonstration and evaluation of commercial system for Type I and II tank heel retrieval (FY00, TFA & EM-30).

Solids "Clinker" Size Reduction to Support Retrieval
- Test and evaluate industry technology for solids size reduction.
  - Assess available technologies for clinker breakup and mobilization for retrieval and develop functions and requirements (FY99, TFA).
  - Solicit industry to develop and test methods for breaking up consolidated sludges, etc. Conduct cold testing of industrial processes and downselect most promising technologies

(FY99, TFA). Decision point for demonstration.

- Fabricate prototype system and conduct cold testing.
  - Identify SRS tank for demonstration and develop specific functions and requirements for a commercial system (FY00, TFA & EM-30).
  - Fabricate prototype systems through contract with selected vendor and conduct cold testing to demonstrate the performance of the systems. (FY00, TFA & EM-30). Decision point for implementation.
- Demonstrate and deploy system to support retrieval at SRS.
  - Design and fabricate full-scale equipment (FY01, TFA & EM-30).
  - Deploy system in SRS HLW tank for solids size reduction (FY01, EM-30).

Chemical Cleaning

- Test and demonstrate Russian chemical tank cleaning methods for application to SRS HLW tanks to support tank closure.
  - Assess Russian chemical tank cleaning methods and evaluate options for U.S. application (FY98, TFA).
  - Develop and test chemical cleaning methods for SRS application and downselect for cold testing (FY99, TFA).
  - Conduct cold verification testing of chemical cleaning methods (FY00, TFA & EM-30).
  - Complete initial hot demonstration of chemical cleaning to evaluate performance and support tank closure (FY00, TFA & EM-30). Decision point for implementation.

Enhanced Sluicing and Waste Mobilization for Hanford - Work activities to support Hanford's needs for enhanced sluicing and waste mobilization include

Enhanced Sluicing

- Develop enhancements to support C-106 sluicing campaign.
  - Assess enhancements and test components/systems for enhancement of the sluicing strategy on project W-320 (FY98, TFA & EM-30).
  - Recommend low-cost changes to W-320 to enhance performance of existing system (FY98, TFA & EM30). Decision point for demonstration.
- Develop and test an enhanced and integrated sluicing system for SST retrieval.
  - Design a sluicing system that can be deployed through a single riser for slurrying and retrieving waste (FY99, TFA).
  - Test and evaluate a prototypic enhanced sluicing system to support Hanford tank retrieval decisions (FY00, TFA). Decision point for demonstration.

Heel Retrieval for HTI (C-106)

- Procure industrial system for SST heel retrieval to support HTI and Hanford privatization.
  - Award contracts to industry to build, test, qualify, and retrieve heel from tank C-106 (FY98, TFA & EM-30).
  - Complete detailed design of equipment and testing of critical components for industry retrieval systems (FY98, TFA & EM-30). Decision point for downselect to one vendor for C-106 retrieval.
  - Fabricate retrieval system for heel retrieval (FY99, TFA & EM-30).
- Demonstrate and deploy heel retrieval from C-106.
  - Complete initial site upgrades to support vendor retrieval, and conduct qualification and mock-up/training tests of vendor and retrieval system (FY00, TFA & EM-30).

- Demonstrate heel retrieval using vendor system and operations (FY01, TFA & EM-30). Decision point for implementation.

Enhanced Mobilization of DST Wastes

- Test, evaluate, and deploy the sonic probe or other selected system for enhancements to retrieval of DSTs.
  - Complete testing and evaluate performance of the system for enhancement to mixer pumps as well as to other technologies. Support EM-30 DST retrieval program at Hanford (FY99, TFA & EM-30).
  - Deploy the system during DST mixer pump operations to evaluate system for improved tank cleaning and retrieval (FY00, TFA & EM-30).

Other Related Work

- Design for Remote Maintenance (Robotics: FY98, $400K)
- Houdini-II (Robotics: FY98, $1000K)
- OHF Heel Removal (Robotics: FY98, $700K)
- Industry (FY98, $50K; FY99, $200K; FY00, $100K)
- Tarzan (Robotics: FY98, $250K [note: does not appear on TFA funding tables])
- Mixing Processes in High-Level Waste Tanks (EMSP: FY96, University of California at Berkeley)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	3775	4325	3525
EM-50 Crosscut Programs	2100		
EM-50 Industry/University/International	50	200	100
EM-30/40	9700		
Total	15625	4525	3625

Problem Element Title: 1.2.1.4 Transfer Waste

Problem Element Description

Waste transfer operations are required after retrieval to move the waste to storage, to provide supernate for use in a retrieval operation, or staging of wastes for subsequent blending or pretreatment. Transfers may occur from tank-to-tank or tank to processing facility and can cover a distance of several miles.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary SR-2004	616	SRS	Methods to Unplug Waste Transfer Lines
Retr 1	679B	Hanford	Waste Conditioning for Tank Heel Transfer
TK-03	606	ORR	Oak Ridge National Laboratory Sludge Mixing and Mobilization
Secondary TK-02	610	ORR	Oak Ridge National Laboratory Tank Solid Waste Retrieval

Problem Statement

During transfers, pipeline plugging has occurred at most sites and can result in very costly delays and intensive efforts to mitigate the plugging. Methods are needed to prevent plugging and to mitigate plugged lines if it cannot be avoided.

Waste Conditioning for Transfer

At Hanford, SRS and ORR, the sludge and hard heel retrieval rates, which are influenced by the chemistry/speciation of sludges, may be too slow for the proposed processing schedule. Furthermore, the chemistry of the slurry from the sludge retrieval process may need to be adjusted to prevent plugging of transfer lines and other operational problems. In addition, the mixing of the heel from one tank (e.g., 106-C as part of the Hanford Tanks Initiative) with the slurry or heel of another tank must be done so that the mixture is compatible. The influence of the retrieval and transfer processes on downstream waste pretreatment operations, such as enhanced sludge washing at Hanford, must be understood to avoid adverse impacts on operations and performance. Information is needed on conditioning requirements, speciation, and design envelopes of acceptable compositions for processing and mixing. In addition to chemistry/speciation of the materials, physical properties

of the sludge may impact waste transfer. Tank waste has aged for several decades, and solids of various sizes have formed that must be retrieved and treated. How the solids are mobilized, reduced in size, transferred, and treated will have an impact on the overall cost and viability of the retrieval and downstream pretreatment processes. There is a need to investigate the impact of large particle transport, develop performance specifications for acceptable sludge properties, and conduct an engineering evaluation on potential in-tank our near-tank size reduction and/or conditioning techniques before transport for these dry/hardened sludges. Assistance to the retrieval team in preventing or solving problems with retrieval and transport is also needed.

Pipeline Unplugging

As the tank clean-out and decommissioning program becomes active at SRS, there is an increasing potential that the transfer lines that are in place will become plugged (unable to facilitate waste transfer from one tank to another or from tanks to the DWPF ITP, or saltstone, etc.). In fact, the DWPF recycle evaporator drain line plugged in August 1997. Transfer systems will potentially become plugged if the solids concentration of the material being transferred increases beyond the capacity of the prime mover, which could be a jet or a pump. This can happen due to the solids settling out within the pipe as well as chemical precipitation/
crystallization. Safe and cost effective pipeline unplugging systems are needed to mitigate future problems.

Path to Solution

- Evaluate the effects of physical and chemical conditions on waste rheology and transfer for Hanford, ORR, and SRS waste types to identify operating regimes that increase the risk of transfer line plugging. Develop and test waste conditioning approaches to reduce the risk of plugging and expand the acceptable operating envelopes.
- Adapt and test commercial systems for pipeline unplugging and perform side-by-side testing to evaluate the merits of multiple systems.
- Develop and deploy a waste conditioning compact processing unit (CPU) to ensure successful transfer of ORR GAAT tank wastes and provide lessons learned to Hanford and SRS.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
1510	OR-43203	Waste Conditioning CPU	Demonstration

- Conduct tank waste heel compatibility testing within the Hanford Tanks Initiative to identify slurry monitoring and waste conditioning requirements for C-106 heel retrieval.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	SR-HL01/02	Blockage Location Tools	Engineering Development
N/A	SR-HL01/02	Blockage Removal Tools	Engineering Development

FY98-FY00 Scope and Schedule

Waste Conditioning for Transfer - Work activities to address ORR and Hanford needs for waste conditioning for transfer, and to support SRS' need for pipeline unplugging techniques (see problem element 1.2.1.4 Transfer Waste) are focused on both near-term processing equipment for ORR GAAT and longer term bench-scale investigations to better understand solution rheology and

plugging phenomena to identify waste conditioning requirements for Hanford and SRS. Efforts will include

Waste Conditioning Compact Process Unit for ORR GAAT - Work activities to support ORR's need for conditioning ORR GAAT sludges for transfer will integrate CMST monitoring technologies (see problem element 1.2.1.6) and commercial equipment. Efforts will include

- Design, fabricate, and deploy a waste conditioning CPU for ORR GAAT retrieval and transfer.
  - Develop functional requirements for the GAAT waste conditioning CPU (FY98, TFA & EM-40).
  - Test CPU components with actual wastes and complete analysis (FY99, TFA & EM-40).
  - Complete final design of the waste conditioning CPU grinder system (FY99, TFA & EM-40). Decision point for demonstration.
  - Test grinder system and Install CPU at ORR GAAT for use in retrieval and transfer operations (FY99, TFA & EM-40).

Prevention of Pipeline Plugging -Waste Conditioning Requirements - Work activities to support Hanford and SRS' needs for understanding and preventing transfer line plugging will include

- Identify chemical and physical parameters that influence pipeline plugging.
  - Develop or adapt a test system to evaluate potential for settling, plugging, and erosion/corrosion of transport lines based upon pipeline geometries and measured waste properties (FY98, TFA & EM-50 University Programs).
  - Develop test plan and initiate investigation of both physical and chemical plugging and settling mechanisms (FY98, TFA & EM-50 University Programs).
  - Complete tests to determine minimum settling velocity for particles; erosion factors, potential for precipitation and adherence of waste to pipe walls during transport. Incorporate instrumentation that will develop correlations between measurements and system performance (FY99, TFA & EM-50 University Programs).
- Establish waste conditioning functional requirements.
  - Provide operational recommendations to quantify desired pressure drops and flow rates for pumps to achieve adequate safety factors for safe transport (FY-00, TFA & EM-50 University Programs). Decision point for demonstration.
- Analyze Hanford C-106 heel to identify waste-specific issues and develop waste conditioning specifications.

Complete analysis of tests on Hanford Tank C-106 heel to determine compatibility with DST receiver tank wastes(FY00, TFA & EM-30). Decision point on waste conditioning requirements for HTI.

Pipeline Unplugging - There are three key issues that should be examined with regard to transfer line blockages. First, there needs to be an understanding of what factors contribute to line blockage. Identifying these factors will enable the implementation of programs and processes to help preclude the formation of blockages. Second, once a blockage has occurred there must be a method to locate and evaluate the blockage. Third, once the blockage is located and evaluated there must be a method of unplugging the line without causing damage. Pipeline plugging is important to SRS, Hanford, and ORR. Related activities will be conducted to develop waste conditioning methods and procedures to reduce the potential for pipeline plugging (problem element 1.2.2.3). Work activities to support SRS's need for pipeline unplugging will include:

- Develop blockage prevention methods.
  - Develop and implement models to predict formation of pipeline blockages (FY98, EM-50

University Programs).
  - Develop and operate a test bed to study blockage phenomena and validate the blockage models and provide a facility that would be available for the testing of blockage location and removal tools (FY99, EM-50 University Programs).
- Demonstrate blockage location tools.
  - Develop specifications and solicit industry for technology to locate blockages in transfer lines (FY98, TFA & EM-50 University Programs).
  - Select industrial partners to provide and demonstrate tools to locate and/or evaluate transfer line blockages (FY99, TFA & EM-50 Industry Programs).
  - Develop and test transfer line blockage location tools (FY99, TFA & EM-50 Industry Programs).
  - Demonstrate industry technologies for locating blockage and evaluate performance using simulants (FY00, TFA, EM-50 Industry Programs, EM-50 University Programs). Decision point for demonstration.
- Demonstrate blockage removal tools.
  - Develop specifications and solicit industry for technology to remove blockages in transfer lines (FY98, TFA & EM-50 University Programs).
  - Select industrial partners to provide and demonstrate tools to remove blockages from transfer lines (FY99, TFA & EM-50 Industry Programs).
  - Develop and test transfer line blockage removal tools (FY99, TFA & EM-50 Industry Programs).
  - Demonstrate industry technologies for removing pipeline blockage sand evaluate performance using simulants (FY00, TFA, EM-50 Industry Programs, EM-50 University Programs). Decision point for demonstration.

Other Related Work

- Unplug Waste Transfer Lines (Industry Programs: FY99, $900K; FY00, $1525K)
- Waste Conditioning for Transfer (University Programs [FIU]: FY98, $Undertermined)
- Improved Systems for Tank Sludge Retrieval, Conditioning, and Transfer (Technology Deployment Initiative: FY97, Oak Ridge Operations Office)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA		450	650
EM-50 Crosscut Programs			
EM-50 Industry/University/International		900	1525
EM-30/40			
Total		1350	2175

Problem Element Title: 1.2.1.5 Detect and Mitigate Leaks

Problem Element Description

Tank leakage is a critical concern during long- and short-term waste storage, as well as during retrieval operations. This problem element covers the detection of leaks from storage tanks and the mitigation or repair of those leaks to prevent widespread contaminant migration. Baseline leak detection includes the use of dry wells, radiation sensors below tanks, and tank liquid level measurement. No baseline methods exist for leak repair or leak mitigation. Subsurface barrier technologies are an example of the types of mitigation methods that would fit within this problem element.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary Retr-4	681	Hanford	Tank Leak Mitigation Systems for Underground Single-Shell Waste Storage Tanks (SSTs)
Secondary 544	544	Hanford	Tank Leak Mitigation Systems
384	384	SRS	Develop Leak Repair Technologies

Problem Statement

The use of past-practice sluicing for SST waste removal involves the addition of liquid to tanks and therefore increases the potential for waste leakage to the environment. Leakage mitigation applies to all SST retrieval, including retrieval during Phase I and preparation of the Phase II specification. Mitigating systems that improve on the capabilities of the current baseline approach are needed. The objective is to prevent, curb, or eliminate the possibility or extent of liquid waste leakage from underground storage tanks into the surrounding soils. If cost-benefit, risk-reduction, and alternatives evaluations of new mitigating technologies determine that deployment, implementation, and operation is feasible, then further evaluation should be pursued. Such evaluations may include demonstrations and testing. Example concepts that could be evaluated include retrieval methods which minimize the potential for leakage, leak point and potential leak point location, "seek-and-seal" devices and methods, administrative approaches that maximize the use and coordination of currently available tools and methods, sheet barriers, close-coupled grout injection barriers, and dry-air containment barriers.

Problem Element Title: 1.2.1.5 Detect and Mitigate Leaks

Path to Solution

- Evaluate state-of-the-art in leak mitigation and repair within DOE, U.S. industry, and internationally.
- Develop multiyear program to develop, test, and demonstrate systems for leak mitigation and repair based on user input on performance requirements and the current technology status.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	RL-TW04	Tank Leak Mitigation/Repair	Engineering Development

FY98-FY00 Scope and Schedule

The TFA, in conjunction with the Characterization, Monitoring, and Sensors Technology Crosscutting Program, made prior investments in leak detection technology and adapted a subsurface plume remediation monitoring technology to leak detection for radioactive storage tanks. By combining the electrical resistance tomography technique with the push-mode cone penetrometer technology, rapid and low cost deployment of leak detection systems was demonstrated. This approach is now ready for field demonstration and deployment.

Leak Mitigation & Repair - Work activities to support Hanford's need for tank leak mitigation and repair will include a 2-phase industrial procurement approach.

- Assessment of tank leak detection and mitigation technology.
  - Develop specifications for an industry solicitation to perform an assessment of current leak detection and mitigation technology (FY98, TFA).
  - Solicit industry and select performer to assess the state of the art in Industry and within the DOE complex for leak detection and mitigation. Evaluate user barriers to implementation of detection and mitigation techniques (FY98, TFA, EM-30, & EM-50 Industry Programs).
  - Complete assessment and recommendations on detection and mitigation approaches. Develop industry solicitation to support phase 2 of the tank leak detection and mitigation procurement (FY99, TFA, EM-30, & EM-50 Industry Programs). Decision point for Phase 2 procurement.
- Develop and demonstrate tank leak detection and mitigation systems.
  - Solicit and select industry performer(s) for tank leak detection and mitigation development and testing. Select multiple performers for future downselection (FY99, TFA & EM-50 Industry Programs).
  - Develop and cold test leak detection and mitigation systems. Evaluate performance of systems (FY00, TFA & EM-50 Industry Programs). Decision point for demonstration (optional phase III of procurement).
  - Downselect leak detection and mitigation systems for hot demonstration and deployment (FY00, TFA, EM-30, and EM-50 Industry Programs).
  - Demonstrate leak detection and mitigation in selected Hanford tank to support retrieval operations (FY01, EM-30).

Other Related Work

- Tank Leak Detection and Mitigation (Industry Programs: FY99, $400K; FY00, $500K)

Problem Element Title: 1.2.1.5 Detect and Mitigate Leaks

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA		250	300
EM-50 Crosscut Programs			
EM-50 Industry/University/International		400	500
EM-30/40			
Total		650	800

Problem Element Title: 1.2.1.6 Monitor & Control Retrieval Process

Problem Element Description

Retrieval of tank wastes and transfer of the wastes between tanks and to processing facilities requires movement of highly variable mixes of solids and liquids through transfer piping. Monitoring and control of the wastes being transferred is necessary to ensure that pipeline flow is maintained. Solids settling, precipitation, or rheological property changes could result in pipeline plugging or failure if not monitored closely.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary TK-04	607	ORR	Oak Ridge National Laboratory Sludge Mixing and Slurry Transport
Retr-13	683	Hanford	High Accuracy Psychrometric/Flow Measurements for Determining Tank Evaporation Rates
PW9	674	Hanford	Representative Sampling and Associated Analysis to Support Operations and Disposal
Saf 1	664	Hanford	Criticality Basis - Actinide Studies
Secondary Retr 1	679	Hanford	Establish Retrieval Performance Evaluation Criteria

Problem Statement

Monitoring and control of retrieval operations must consider issues of representative sampling and analysis and potential pipeline plugging, gas entrapment, and criticality. These issues may impact schedule, cost, and safety if they are not adequately monitored and considered before and during retrieval operations.

Representative sampling and analysis

A representative, and preferably rapid, sampling and analysis system has to be developed and demonstrated so that waste transferred from DOE-RL can be validated for appropriate composition for use by the LLW and HLW privatization contractors. Current grab samplers consisting of "bottle-on-a-string" are used for slurry/supernate sampling. This system of sampling has been found to be cross contaminated with material from higher elevations above the desired sample depth as it is withdrawn from the tank. Although this cross contamination is proportional, it could skew the sample results. Also, this method cannot be performed during active mixing system operation,

therefore allowing time for in-tank stratification to re-establish before the sampling can be performed. The sampling is a manual operation performed thorough an existing riser using a portable "glove bag" for containment control that has potential for personnel contamination and exposure. With Hanford's existing capabilities it takes weeks or even months to sample and analyze a tank. As the disposal program activities involving 200 Area waste retrieval and privatization proceed, Hanford will need the capability to sample and analyze much more rapidly in order to ensure that DOE provides feeds in accordance with its privatization contracts and with a minimum use of tank space. Representative sampling involving potentially nonhomogeneous waste feed is definitely needed. Long sample and analysis times will cause operations to tie up tanks until analytical results are available to determine how the waste should be staged. Quicker sample/analytical responses will provide more flexibility to the tank system.

Slurry monitoring to prevent pipeline plugging

Measurement of slurry density, viscosity, volume percent solids, and flow are required before and during transport of retrieved tank wastes to ensure that the transport lines will not plug. The estimated cost to replace a plugged transport line at Hanford is $47M. Crucial parameters for maintaining a turbulent slurry flow and avoiding plugging due to excessive solids are a Reynolds number > 22,000, a specific gravity < 1.5, a viscosity < 30 cP, a volume percent solids <30, particle sizes of 0.5-4000 microns (with 95% of the total under 50 microns), and a design velocity of 6 ft/s. In situ tank and transport line sensors to measure slurry density, mass flow, viscosity, volume percent solids, and particle size distribution are needed.

Retrieval and transfer activities in need of near-term slurry monitoring include the gunite and associated tanks at ORR, and the Hanford tanks undergoing retrieval as part of the Hanford Tanks Initiative. For example, heel retrieval from Hanford Tank 106-C is planned in FY99 and the slurry will be transported a distance of more than 1600 ft in a pipeline. ORR plans to conduct a cross-site slurry transfer of about 145,000 gallons of low radioactivity tank waste in FY00 through a 2-in. diameter transfer line. A downselect of the appropriate monitors, installment, and field testing of monitors is needed to provide validated on-line slurry monitoring.

The physical and chemical properties of the retrieved waste must meet certain operational requirements for retrieval and pretreatment operations to be successful. Transfer line pluggage is a concern for operations, and particle size, weight percent solids, and chemistry changes occurring during retrieval impact the efficiency of the downstream pretreatment operations. Sampling, analysis, and monitoring (e.g., sensors) that can provide these data are needed.

Entrapped gas detection through evaporation monitoring

During waste retrieval and transfer of solids, a potential exists for the creation of "slurry growth" conditions (i.e., entrapped gases) in the receiver tank with a subsequent gas release event (GRE) similar to the behavior exhibited by Tank 101-SY. To monitor the waste for the presence of entrapped gases during a retrieval sequence, material balance calculations must account for the evaporative losses from the tank. This requires highly accurate psychrometric and flow measurement capabilities to detect the amount of entrapped gases.

Criticality

All the available data on plutonium chemistry as it related to criticality that has been reviewed indicates that plutonium in Hanford Site fuel reprocessing waste streams can potentially undergo three different types of reactions. These are precipitation as a distinct solid phase; precipitation as a solid solution with other components that are present in certain specific process-dependent waste

streams (lanthanum, bismuth, and zirconium); and adsorption onto major hydroxide and/or oxyhydroxide components such as aluminum, iron, chromium, and manganese, etc. The available tank characterization data does not contain details on the speciation of plutonium in the waste phases (supernate, saltcake, and sludge). Even though the safety analysis has proven that the waste tank contents are highly subcritical, there are several remaining chemical and physical characteristics of the behavior of the actinides in Hanford HLW that are not fully understood. Additional technical analysis of these characteristics are required in support of future waste management activities (e.g., retrieval and pretreatment) to ensure a technically defensible safety basis.

Path to Solution

- Develop a multi-level sampling device with at-tank analysis to support feed staging for Phase I privatization at Hanford.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
2007	RL-TW06	AEA Multi-Level Fluidic Sampling Pump	Engineering Development

- Prepare and downselect several types of on-line slurry monitors for testing and hot deployment at ORR.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
1490	OR-43203	Slurry Monitors	Demonstration

- Deploy appropriate slurry monitors at ORR and Hanford to support users retrieval schedules.
- Develop improved tank evaporation monitoring to reduce the uncertainty of current water balance measurements.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	N/A	Psychrometric/Flow Measurement	Engineering Development

- Evaluate actinide behavior in tank wastes to support the safety basis for retrieval and processing operations.

FY98-FY00 Scope and Schedule

Representative Sampling and Analysis - Work activities to address Hanford's need for representative sampling to support Phase I privatization will include

- Development of a variable depth sampling system.
  - Develop specifications, including requirements on physical and chemical parameter monitoring, to support development and testing of a sampler (FY98, TFA & EM-30).
  - Develop and cold test variable depth fluidic sampling concepts to support system design (FY98, TFA & EM-50 Industry Programs [AEAT]).
  - Complete detailed design of variable depth sampler for Hanford intermediate waste feed staging tank application (FY99, TFA, EM-30, & EM-50 Industry Programs). Decision point for demonstration.

- Demonstrate variable depth sampler at Hanford and integrate with analytical instrumentation requirements (FY00, TFA, EM-30, & EM-50 Industry Programs). Decision point for implementation.

- Development and demonstration of on-line analytical instruments and procedures.
  - Demonstrate selected analytical instruments for on-line measurement. Demonstrate ability to handle two-phase systems, and meet analytical and performance requirements (FY99, TFA & EM-30).
  - Downselect instrument and integrate functions and requirements with the variable depth sampling system development (FY99, TFA & EM-30).
  - Develop analytical procedures, complete documentation, and integrate analytical system into the variable depth sampling system (FY00, TFA, EM-30, EM-50 Industry Programs).
  - Demonstrate analytical methods in conjunction with variable depth sampler initial deployment (FY00, TFA & EM-30).

Slurry Monitoring - Under a current TWRS project (W211), commercial slurry monitors are being tested for their ability to measure slurry transport parameters in-line to avoid plugging. The TFA and CMST crosscut program have also sponsored the development and testing of slurry transport monitors. Work activities in FY98 will include CMST efforts to

- Complete slurry monitoring comparison testing at ORR.
  - Complete comparison testing at the ORR slurry test loop and downselect slurry monitors for final development (FY97, CMST & EM-40).
  - Complete final developments of selected sensors to correct deficiencies identified during comparison testing and prepare for field deployment (FY98, CMST).
  - Deploy selected slurry monitors during GAAT retrieval and waste transfer operations at ORR (FY98, EM-40).

Results of slurry monitoring testing at ORR will also be used to support Hanford's need within the HTI. Work activities will include

- Design, procure, and deploy a slurry monitoring system for C-106 slurry transfer.
  - Establish requirements for monitoring of slurry transfers between C-106 and the DST receiver tank (FY99, TFA & EM-30).
  - Acquire slurry monitoring technologies and integrate them into the transfer system (FY00, TFA and EM-30). Decision point for implementation.

Entrapped Gas Detection - Work activities to address Hanford's need for improved detection of entrapped gases will include

- Development of a high-accuracy psychrometric and flow measurement system.
  - Develop specifications for industrial call for proposals. Review information from the FY 1997 evaluations and past experience with using high-accuracy psychrometric and flow measurement systems under tank farm conditions and ventilation systems. Evaluate the accuracy of psychrometric and flow measurements system testing that has been done by the laboratories and industry (FY98, TFA & EM-30).
  - Solicit industry technology and select provider(s) for development and/or testing (FY99, TFA & EM-50 Industry Programs).
  - Select Hanford tank for a preliminary ventilation system design to support improved psychrometric and flow measurement testing. Conduct testing of industry system(s) under simulated tank configurations to ensure performance requirements are met (FY99, TFA & EM-50 Industry Programs). Decision point for demonstration.
  - Demonstrate improved psychrometric and flow measurement on selected Hanford tank to support retrieval operations (FY00, TFA & EM-30).

Problem Element Title: 1.2.1.6 Monitor & Control Retrieval Process

Criticality Basis - Actinides - Work activities to address Hanford's need for actinide chemistry studies will be initiated in FY99 pending funding and task prioritization, and will include

- Assessment of actinide behavior in tank wastes to resolve key technical issues.
  - Define detailed requirements to address actinide chemistry issues (FY99, TFA & EM-30).
  - Select laboratory or university and develop a detailed test plan and schedule for actinide studies (FY99, TFA & EM-30).
  - Complete Pu chemistry studies and develop criticality analyses (FY00, TFA & EM-30).
  - Complete Am and Cm chemistry studies and limited criticality analyses (FY01, TFA & EM-30).

Other Related Work

- Tank Evaporation Monitoring (Industry Programs: FY99, $500K; FY00, $425K)
- Comparative Testing Pipeline Slurry Monitors (CMST: FY98, $350K)
- Automated Analysis of Tank Samples (Robotics: FY98, $250K)
- Acoustic Probe for Solid-Gas-Liquid Suspensions (EMSP: FY96, Syracuse University)
- On-Line Slurry Viscossity and Concentration Measurement as a Real-Time Waste Stream Characterization Tool (EMSP: FY96, University of California at Davis)
- Slurry Monitoring (Technology Deployment Initiative: FY97, Richland Operations Office)
- AEA Fluidic Sampler (Technology Deployment Initiative: FY97, Savannah River Operations Office)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	500	950	950
EM-50 Crosscut Programs	600		
EM-50 Industry/University/International		500	425
EM-30/40			
Total	1100	1450	1375

Problem Element Title: 1.2.2.1 Calcine Waste and 1.2.2.2 Dissolve Waste

Problem Element Description

Calcination is the baseline technology for solidifying liquid HLW and storing it as a granular solid in underground stainless steel bins within concrete vaults at INEL. This problem element addresses technology development to modify the calcination operating parameters to make them compatible for calcining radioactive liquid waste high in sodium. It also addresses development of methods to dissolve currently stored calcine to support future radionuclide separations that are part of the baseline plan for waste processing at the INEEL.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary ID-2.1.02	640	INEEL	Process Flow Sheet to Process Sodium-Bearing Waste
ID-2.1.05	644	INEEL	Dissolution of Future Calcines

Problem Statement

Calcining blended acidic wastes for interim storage has been the baseline technology for INEEL's tank waste stored at the ICPP. The remaining wastes, however, are higher in sodium and the waste stream with which they have been blended in the past to reduce the sodium concentration is no longer available. Therefore, the current calcination process must be modified so that a product that meets performance requirements is produced. In addition, the waste processing baseline plan for INEEL includes a separations flowsheet option that is being pursued, and requires dissolution of calcines prior to radionuclide separation. Therefore, both technical advancements to support future calcination and developments of methods to dissolve existing calcine are required to meet the processing schedule for INEEL.

Advanced Calcination

Radioactive liquid waste containing large quantities of sodium has accumulated over the years and is stored in the ICPP tank farm at INEEL. This waste is referred to as sodium-bearing waste (SBW), and was generated as a result of extraction system solvent cleanup and decontamination efforts. Sodium nitrate and potassium nitrate are major components of the SBW. SBW is difficult to calcine due to agglomeration and caking of molten sodium nitrate and potassium nitrate that persist in the

calcine product. The pure component decomposition temperatures for sodium nitrate and potassium nitrate are 380° C and 400° C, respectively. However, the thermal decomposition of the nitrates is not fully achieved by calcination at 500° C (the normal operating temperature of the facility) due to mass transfer and kinetic limitations and due to the formation of eutectic phases during drying. INEEL's Settlement Agreement with the State of Idaho requires that the SBW be calcined by 2012. This commitment cannot be met using the established SBW flowsheet due to the copious quantity of aluminum nitrate that is required. Therefore, to meet the objectives of increased throughput, reduced waste volumes, and reduced cost, alternative calcination schemes must be investigated.

Calcine Dissolution

The waste processing baseline plan for INEEL includes a separations flowsheet option that is being pursued, and requires dissolution of calcines prior to radionuclide separation. Calcine must be dissolved to put it in a form that is compatible with radionuclide separation technologies. Parameters affecting dissolution efficiency must be defined and scale-up and design of a calcine dissolver must be completed to support Title 1 design.

Path to Solution

- Develop methods to denitrate sodium-bearing waste before calcination to reduce gas load and NOx release.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
82	ID-HLW03	Thermal Denitration	Engineering Development

- Optimize the calcining flowsheet to handle sodium-bearing wastes through pilot-plant studies.
- Evaluate the chemistry and dissolution behavior of calcines and bench test preferred methods to support flowsheet development.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
881	ID-HLW03	Calcine Dissolver	Engineering Development

FY98-FY00 Scope and Schedule

Advanced Calcination - Work activities to support INEEL's need for advanced calcination of their sodium-bearing waste will include

- Develop a process flowsheet, specifications for process equipment, and test prototype components for thermal denitration.
  - Complete initial laboratory-scale (10-cm pilot plant) tests with simulated low-activity waste to establish optimum temperature and additives for the high-temperature flowsheets (FY98, TFA & EM-30).
  - Identify the acceptable operating envelope using a wide range of feed compositions (FY98, TFA & EM-30).
  - Perform demonstration testing based on the FY98 results to support the full-scale design with engineering performance and cost data.
  - Demonstrate advanced calcination using 15-cm pilot plant and unique waste compositions (FY99, TFA & EM-30).

- Test alternative process configurations such as rotary kiln and auger-driven moving bed to compare calcination performance. Complete performance specifications for full-scale thermal denitration based on pilot-scale testing (FY99, TFA & EM-30). Decision point for demonstration.

Calcine Dissolution - Work activities to support INEEL's need for calcine dissolution will include

- Develop dissolution rate and kinetic expressions for calcine dissolution.
  - Complete laboratory tests to determine rate and kinetic expressions for calcine dissolution using surrogate waste (FY99, TFA & EM-30).
- Evaluate dissolver equipment designs and test preferred concepts at a bench scale.
  - Complete conceptual design of pilot plant dissolver based on laboratory kinetics experiments.
  - Demonstrate calcine dissolution at the bench-scale using surrogate wastes and pilot-plant design. Validate design and scale-up relationships from laboratory scale (FY00, TFA & EM-30). Decision point for demonstration.

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	350	1020	1000
EM-50 Crosscut Programs			
EM-50 Industry/University/International			
EM-30/40	1144	1119	1343
Total	1494	2139	2343

Problem Element Title: 1.2.2.3 Prepare Retrieved Waste for Transfer and Pretreatment

Problem Element Description

The pretreatment facilities will require feed streams that are compatible (e.g., density, solids content, rheology, particle size, blending reactions, chemistry) with pretreatment unit operations. This "interface" with retrieval and transfer focuses on understanding the effects of properties on pretreatment process efficiency to ensure selection of appropriate performance requirements during retrieval, conditioning, transfer, and storage of wastes.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary PW6	671	Hanford	Avoidance of Formation of Solids in Phase I Liquid Tank Wastes

Problem Statement

Physical and chemical properties of tank waste can impact the efficiency of pretreatment. Various chemical combinations can lead to gelation or precipitation, which will adversely impact processing. A better understanding of sludge and saltcake chemistry and its impact on dissolution rates, pipeline transfers, and mixing operations is needed.

Prediction and Avoidance of Solids in Tank Wastes

Solids and gels are known to form in the Hanford tank wastes when the solution ionic strength is decreased. Transfer lines have been plugged when solids or gels inadvertently formed. Knowledge of the solubility envelope for the waste is necessary to avoid unwanted precipitation or gel formation in supernate. There are both immediate needs for information on solubility envelopes for the DST supernate and saltcake that is needed to support Privatization (Phase I) at Hanford, as well as mid-term need to support Privatization (Phase II) developments to improve prediction of solubility envelopes for sludge washing, leaching, and saltcake dissolution solutions.

During Phase I of privatization at Hanford, TWRS will be retrieving DST supernate/saltcake. The current plan is to dissolve the saltcake/precipitated salts by the addition of water. While these precipitated salts are expected to go back into solution, this has not been verified with actual wastes. If solids remain undissolved, they can cause operational difficulties during transfer and can result in the transferred stream being greater than 5% solids, which is the allowable maximum specified in the privatization contracts. In addition, the chemistry of these concentrated supernates is quite complex,

and the dilution itself may cause additional precipitation. While dilution may aid in the dissolution of sodium nitrate, it may also cause gibbsite (aluminum hydroxide) to precipitate. Therefore, understanding the conditions that avoid precipitation in supernate and saltcake solutions is important to the DST retrieval operations for Phase I of privatization. Thermodynamic models, which help predict the occurrence of this precipitation, must be verified.

Sludge washing and leaching performance and saltcake dissolution evaluations are currently based on empirical data extrapolated from individual tanks to groups of tanks based on waste types. Improvements in processing efficiency are expected if the wash, leach, and dissolution processes are based on an understanding of the dissolution thermodynamics and kinetics rather than just empirical data. Water usage and makeup chemical addition can also be reduced, which together with the improvement in efficiency can reduce the amount of HLW glass produced. Solids formation in sludge washing solutions, although related to the same thermodynamic modeling issues of the saltcake and supernate solutions, is addressed in Problem Element 1.2.2.7.

Path to Solution

- Evaluate saltcake dissolution and concentrate re-precipitation phenomena in complex solutions to upgrade thermodynamic models to support retrieval and storage operations at Hanford.

FY98-FY00 Scope and Schedule

Prediction and Avoidance of Solids in Tank Wastes - Work activities to support Hanford's need for confirmation and improvement of thermodynamic predications of waste solubility to support processing and transfer operations will include

- Verification of operating envelope for Phase I supernate/saltcake.
  - Establish university/national laboratory/Hanford TWRS Contractor team. Complete evaluation of previous model improvement efforts and solubility data from actual waste solutions, and develop an integrated plan for testing surrogates and actual wastes, and thermodynamic modeling of supernate/saltcake solutions (FY98, TFA, EM-30, EM-50 University Programs).
  - Complete tests on initial saltcake samples and compare to surrogate waste tests and model predictions. Identify data gaps and inadequacies of the thermodynamic model and/or surrogate test results (FY98, TFA , EM-30, EM-50 University Programs). Decision point for FY99 testing.
  - Prepare test plan to address identified gaps and improve model performance (FY99, TFA, EM-30, EM-50 University Programs).
  - Complete follow-on testing with saltcake samples and surrogates to address issues from FY98 testing. Validate surrogate test data and model predictions (FY99, TFA, EM-30, EM-50 University Programs).
  - Incorporate improved thermodynamic data into Hanford models and transfer to TWRS organization for use in establishing appropriate operating envelopes (FY99, TFA, EM-30, EM-50 University Programs). Decision point for demonstration.

Other Related Work

- Saltcake Dissolution (University Programs: FY98, $150K)

Problem Element Title: 1.2.2.3 Prepare Retrieved Waste for Transfer and Pretreatment

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	425	450	
EM-50 Crosscut Programs			
EM-50 Industry/University/International	150		
EM-30/40			
Total	575	450	

Problem Element Title: 1.2.2.4 Clarify Liquid Stream

Problem Element Description

Liquid wastes retrieved from storage tanks require clarification (i.e., filtration, centrifugation, decanting) to remove suspended solids such as sludges or precipitates that may interfere with downstream processing.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary TK-05	609	ORR	Oak Ridge National Laboratory Tank Sludge and Supernatant Separations
ID-2.1.04	643	INEEL	Method to Separate Undissolved Solids from Sodium-Bearing Waste & Dissolve Calcine
PW13	678C	Hanford	SLS Hanford (CUF)
Secondary 563	563	Hanford	Demonstrate Filtration for Pretreatment Solid-Liquid Separation
176	176	ORR	Liquids-Solids Separations Studies

Problem Statement

The priority need for solid-liquid separation has been identified by the four primary tank sites as a critical problem.

SRS has a decade of experience designing, testing, and operating solid-liquid separation for in-tank precipitation; however, this technology is not directly applicable to all of the solid-liquid separation problems at the four sites. For example, at ORR, treatability studies performed indicate that standard clarification/filtration equipment will not be adequate. Testing of alternative filter systems is required to support the separation of undissolved solids from the sodium-bearing and dissolved calcine wastes at INEL, the late wash precipitate at SRS, various liquid LLW streams at ORR including TRU sludges, and strontium/TRU-bearing retrieval solutions, supernatants and wash solutions for phase I privatization at Hanford. At INEL, if the undissolved solids are not adequately removed, the solvent extraction and ion-exchange processes used for TRU, cesium, strontium, and technetium separation will have a high probability of failure. Separation of fine solids and colloidal particles from Hanford supernates is required to ensure that the low-level waste stream will have

acceptably low concentrations of insoluble radioactive material, principally strontium and TRU radioisotopes. At ORR, solid-liquid separation will be needed during the gunite and associated tank retrieval demonstration to treat excess sluice water for disposal, to concentrate tank sludges for feed to a treatment process, or reduce volume of retrieved sludges before transfer to interim storage tanks in the ORR active waste system.

Path to Solution

- Obtain performance data on cross-flow filtration to remove undissolved solids from acid waste and to evaluate regeneration with back pulse or non-acid wash at INEEL.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
350	ID-HLW-03	Cells Unit Filter (CUF)	Engineering Development

- Obtain operational experience on a larger scale system by preparing a hot demonstration on wastes for transfer to Melton Valley Storage Tanks (MVST) at ORR.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
350	OR-43203	Cross-flow Filter	Demonstration

- Complete testing for Hanford Tank Waste Remediation System of radioactive wastes using the Cells Unit Filters at Hanford to support Phase I of privatization.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
350	RL-TW06	Cells Unit Filter (CUF)	Engineering Development

- Incorporate solid-liquid separations' performance data and lessons learned into the pretreatment analysis tool to support site decision making.

FY98-FY00 Scope and Schedule

Work activities to address ORR, INEEL, and Hanford needs in solid-liquid separation will include

- Deployment of a full-scale cross-flow filtration system for MVST wastes at ORR.
  - Complete fabrication and cold testing of the SLS system initiated through procurement specification development in FY97 (FY98, TFA & EM-30).
  - Demonstrate SLS system on actual wastes at MVST. Decontaminate system and upgrade/repair system as needed for transfer to EM-30 for operations (FY99, TFA & EM-30). Decision point for implementation.
- Testing of a Cells Unit Filter (CUF) at INEEL to support Title 1 Design.
  - Complete SLS/CUF testing using dissolved calcine and evaluate performance for use in Title I Design (FY98, TFA & EM-30). Decision point for demonstration.
  - Decommission CUF system and remove from INEEL hot cell (FY98, TFA & EM-30).
- Testing of a CUF at Hanford to resolve uncertainties and support design for feed preparation activities.
  - Complete investigations into effects of ionic strength on deagglomeration and CUF system performance (FY99, TFA & EM-30).

Problem Element Title: 1.2.2.4 Clarify Liquid Stream

- Perform head-to-head comparison tests of Mott and Graver filters to provide direct comparison data (FY99, TFA & EM-30).
- Complete bench-scale sludge testing to resolve outstanding technical uncertainties associated with peptization, deagglomeration, variability in waste feed characteristics, and maximum solids loading (FY00, TFA & EM-30). Decision point for demonstration.

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	725	1575	1400
EM-50 Crosscut Programs			
EM-50 Industry/University/International			
EM-30/40	680	430	592
Total	1405	2005	1992

Problem Element Title: 1.2.2.5 Remove Radionuclides

Problem Element Description

Radionuclide removal from tank waste supernate is a primary requirement at all of the DOE waste tank sites because the presence of radionuclides directly impacts the waste immobilization decisions and the volume and cost of LLW and HLW generated. The primary radionuclides of concern are cesium, strontium, technetium, and TRU. Removal processes for these radionuclides include in-tank, at-tank (compact processing), and out-of-tank (processing facility unit operations) which separate and concentrate the radionuclides of concern.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary ID-2.1.06	645	INEEL	Solvent Extraction & Ion-Exchange to Remove TRU, Sr, Tc & Cs from ICPP Tank Farm
TK-11	605A	ORR	ORNL Cs Removal Closeout
SR-2006	618	SRS	Evaluate Alternative Precipitating Agents and Ion Exchange Media for Decontamination of High Level Waste Salt Solutions
Secondary 533	533	Hanford	Technetium Removal (Need from FY96)
ID-2.1.11	646	INEEL	Characterize & Remove RCRA Listed Wastes from High & Low Activity Fractions
SR-2018	630	SRS	Develop Alternatives to Monosodium Titanate for Alkaline Strontium and Actinide Removal

Problem Statement

Cesium Removal from Alkaline Wastes

The use of the tetraphenylborate ion (TBP-) for precipitation of radioactive cesium from HLW at SRS yields high generation of benzene. Other methods of removing radioactive cesium from HLW that avoid use of TPB would eliminate benzene generation. Alternative cesium removal agents may also eliminate the acid hydrolysis and Late Wash processes in the Defense Waste Processing Facility. A cesium-specific precipitating agent is needed. Using a precipitating agent avoids the need for the system reconfiguration required for ion exchange.

At ORR, the GAAT, OHF, and BVEST wastes must be retrieved, consolidated in the MVST, and immobilized to meet transportation and disposal requirements for the Waste Isolation Pilot Plant

(WIPP) or the NTS. The supernate has been historically treated by grouting the waste for disposal, presumably, at the Nevada Test Site. Increasing levels of cesium in the waste (from new research activities and concentration of legacy waste) requires that cesium be removed prior to solidification. A demonstration of Cs removal using CSTs has been underway. Performance and cost data from actual processing is needed to ensure that deployment of Cs removal using crystalline silicotitanate (CST) is appropriate.

Alternative cesium removal technologies are desired for SRS to backup the baseline in-tank precipitation process and allow potential improvements in efficiency and life-cycle costs. For ORR, performance and cost data from actual processing is needed to ensure that deployment of Cs removal using CST is appropriate.

Radionuclide Removal from Acid Wastes

TRUs, Cs, and Sr comprise less than one percent of the total INEEL radioactive waste volume. If these elements can be removed from the bulk (inert) elements in the waste, a significant reduction in the volume of HLW would be realized. Treatment technologies applicable to strontium, technetium, TRU, and cesium in INEEL waste streams must be developed and tested to provide cost and performance data for final baseline technology selection. Solvent extraction and ion-exchange technologies must be demonstrated on actual INEEL radioactive waste streams to ensure full-scale processes will adequately recover the active constituents necessary to convert the bulk of the waste to LLW.

Path to Solution

Cesium Removal from Alkaline Wastes:

- Complete demonstration and transfer the CST removal system for use on cesium at ORR.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
21	OR-38105	CSTs for Cs Removal	Implementation

- Evaluate crystalline silicotitanate and other sorbents to augment the current tetraphenylborate process for SRS.

Radionuclide Removal from Acid Wastes

- Select appropriate separations processes for TRU, technetium, strontium, and cesium removal.
- Test and demonstrate methods for TRU, technetium, strontium, and cesium removal over a 3-year period.
- Produce performance and cost data to support an INEEL decision on their baseline radionuclide separation unit operations.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
347	ID-HLW03	TRUEX & SREX	Engineering Development

- Incorporate radionuclide removal systems' performance data and lessons learned into the pretreatment analysis tool to support site decision making.

Problem Element Title: 1.2.2.5 Remove Radionuclides

FY98-FY00 Scope and Schedule

Cesium Removal Demonstration for ORR MVST Wastes - Work activities in FY98 to address ORR's Cs removal need will include

- Closeout Cs-removal demonstration (CsRD) project.
  - Decontaminate and demobilize the Cs-removal demonstration CPU system (FY98, TFA & EM-30).
  - Transfer the CsRD CPU to EM-30 ORR operations (FY98, TFA & EM-30).
  - Complete CsRD demonstration performance evaluation and transfer lessons learned to SRS and Hanford (FY98, TFA). Decision point for implementation.

Alternative Cs Removal for SRS - Work activities to address SRS's need for improved Cs removal technologies will include

- Evaluate advanced separations for SRS.
  - Continue ESP activities to evaluate Cs removal options to support both HLW separations and DWPF recycle stream separations (see problem element 1.1.4.2) (FY98, ESP).
  - Conduct engineering analysis of the cost of using CST and other sorbents compared to NaTPB. Perform laboratory tests of a continuous flow IX if the analysis shows this to be the preferred approach (FY99, TFA).
  - Complete bench-scale testing of alternatives and establish deployment recommendations and cost analyses to support program planning (FY00, TFA & EM-30). Decision point on demonstration.
  - Develop prototype demonstration system specifications (depending on in-tank or out-of-tank recommendation) and procure system for cold testing and deployment (FY01, TFA & EM-30).

Radionuclide Removal from Acid Wastes - Work activities to address INEEL's need for performance data on solvent extraction radionuclide removal options will include

- Completion of Cs removal tests.
  - Evaluate use of solvent extraction and ion exchange for Cs removal (FY98, TFA, ESP, & EM-30). Decision point for test plan and configuration.
  - Demonstrate Cs removal with actual INEEL waste and report on performance to support Title 1 design (FY98, TFA, ESP & EM-30).
- Demonstrate integrated radionuclide removal flowsheet.
  - Combine separate Cs, Sr, & TRU flowsheets into an integrated system to remove all radionuclides previously demonstrated (FY98, TFA, ESP, & EM-30).
  - Conduct integrated test to determine if any process incompatibilities exist. Provide treated waste to solidification tasks for verification of proposed processes (FY99, TFA, ESP, & EM-30).
  - Close-out project, decontaminate system, and provider performance evaluation data to support Title 1 design (FY99, TFA, ESP, & EM-30). Decision point for demonstration.

Tc Removal from Alkaline Wastes - Non-pertechnetate species in Hanford tank wastes was identified as an important need in FY97 (Need #533). Although Hanford chose not to resubmit this need for FY98, TFA still considers Tc an important issue for privatization Phase II and has recommended that ESP work initiated in FY97 to address this need be completed in FY98. Work activities conducted under the ESP program will include

- Determination of non-pertechnetate species.
- Evaluation of the relative effectiveness of different oxidation processes on the total flowsheet.

- Reporting on the recommended characterization and separation methods for non-pertechnetate species in Hanford tanks.

Other Related Programs

- Advanced Integrated Solvent Extraction System (ESP: CH26C321, FY98, $100K)
- Integrated Solvent Extraction - Tc, Cs, Sr (ESP: OR16C341, FY98, $350K)
- Ligand Modeling and Design (ESP: RL36C331, FY98, $80K)
- Colbalt Dicarbollide Extractant, Khlopin Radium Institute (ESP: FY98, $75K)
- Bench Scale Testing for Separation of INEEL Waste (ESP: ID76C311: FY98 $250K)
- Polyacrylonitrile Engineered Forms, Technical University, Prague (ESP: FY98, $50K)
- Patent Documentation and AMP Engineered Form (ESP: OR16C342, FY98, $200K)
- Process Monitor for Cs-137 Column Breakthrough (CMST: FY98, $250K)
- Process Monitors for Tc-99 Column Breakthrough (CMST: FY98, $300K)
- Characterization and Separation of Non-Pertechnetate Species in Hanford Wastes (ESP: AL17C321, FY98, $300K)
- Advanced Chemical Separations at SRS (ESP: SR16C342, FY98, $125K)
- f-Element Ion Chelation in Highly Basic Media (EMSP: FY96, University of New Mexico)
- Polyoxometalates for Radioactive Waste Treatment (EMSP: FY96, Georgetown University)
- New Anion-Exchange Resins for Improved Separations of Nuclear Materials (EMSP: FY96, Los Alamos National Laboratory)
- Design and Synthesis of the Next Generation of Crown Ethers for Waste Separations: An Inter-Laboratory Comprehensive Proposal (EMSP: FY96, Oak Ridge National Laboratory)
- Architectural Design Criteria for F-Block Metal Ion Sequestering Agents (EMSP: FY96, Pacific Northwest National Laboratory)
- Research Program to Investigate the Fundamental Chemistry of Technetium (EMSP: FY97, Lawrence Berkeley National Laboratory, $900K)
- Synthesis and Characterization of Templated Ion Exchange Resins for the Selective Complexation of Actinide Ions (EMSP: FY97, Johns Hopkins University Applied Physics Lab, $302K)
- Dynamic Effects of Tank Waste Aging on Radionuclide-Complexant Interactions (EMSP: FY97, Los Alamos National Laboratory, $550K)
- Fundamental Chemistry, Characterization, and Separation of Technetium Complexes in Hanford Waste (EMSP: FY97, Los Alamos National Laboratory, $730K)
- Removal of Technetium, Carbon Tetrachloride, and Metals from DOE Properties (EMSP: FY97, Pennsylvania State University, $390K)
- Chemical Speciation of Inorganic Compounds under Hydrothermal Conditions (EMSP: FY97, University of Washington, $850K)
- Potential-Modulated Inercalation of Alkali Cations into Metal Hexacyanoferrate Coated Electrodes (EMSP: FY97, University of Washington, $300K)
- Electrochemical Ion Exchange for Contaminant Removal and Waste Reduction (Technology Deployment Initiative: FY97, Oak Ridge Operations Office)

Problem Element Title: 1.2.2.5 Remove Radionuclides

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	785	1170	700
EM-50 Crosscut Programs	2080		
EM-50 Industry/University/International			
EM-30/40	800	1375	1375
Total	3665	2545	2075

Problem Element Title: 1.2.2.7 Process Sludge

Problem Element Description

Retrieved sludges from tank waste require processing to remove entrained radionuclides for downstream separation and processing, and to remove salts and minerals that may impact downstream vitrification. Processing of sludges primarily involves washing and separations.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary PW7	672	Hanford	Prediction of Gel and Precipitate Formation in Hanford Tank Waste Solutions
PW8	673	Hanford	Enhanced Sludge Wash Process Data for Extended Operations of Phase I and for Phase II RFP
PW13	678A	Hanford	Settle Decant
PW13	678B	Hanford	Pilot Plant
SR-2008	620	SRS	Develop Counter-Current Decantation Process for Sludge Washing
TK-11	605B	ORR	Oak Ridge National Laboratory Tanks Sludge and Supernatant Pretreatment

Problem Statement

Sludges at SRS, Hanford, and ORR will require processing to remove nonradioactive constituents which either adds to the volume of the resulting HLW (e.g., aluminum) or impacts immobilization processing (e.g. chromium, technetium, or phosphate). Technical problems and issues exist in three areas of sludge processing.

Performance Data on the Baseline Enhanced Sludge Washing System

The current baseline pretreatment option for Hanford tank sludges is Enhanced Sludge Washing (ESW) - caustic leaching followed by washing with dilute sodium hydroxide. Testing of the baseline pretreatment process with actual tank sludges is required to confirm (or amend) the assumptions made in the development of the process flowsheet. ESW process data are needed to prepare enough feed to satisfy the maximum order quantity for Phase I, preparation of the Phase II privatization RFP, and for bid evaluation of vendors proposals. Currently, only about 70 to 80 percent of the maximum order quantity for phase I sludge washing has been identified. Additional

feeds must be identified that can satisfy Envelope D after pretreatment to ensure that the private contractors will be able to operate through 2011. In addition to Phase I, a strategy was developed for ESW testing based on obtaining 47 SST and 10 DST sludge samples (Kupfer 1996). Completion of that strategy is necessary to craft the Phase II RFP and to provide enough definitive information for a fair cost estimate for bid evaluation purposes. Additional data on the effect of varying temperature and caustic concentration on leach performance is important.

Sludge Washing Chemistry

By March 1998 a decision will be made in response to Hanford's TPA Milestone M-50-03 on whether ESW produces a reasonable number of HLW glass canisters. A high emphasis needs to be placed on obtaining information on the chromium (Cr) chemistry in the sludges and saltcakes. Testing of high Cr wastes indicates insufficient chromium removal. Cr removal is needed to reduce the impact on the HLW glass volume.

In addition to Cr issues, other chemistry issues may impact the ability to process leach solutions following sludge washing. Solids and gels are known to form in the Hanford tank wastes when the solution's ionic strength is decreased. Transfer lines have been plugged when solids or gels inadvertently formed. Knowledge of the solubility envelope for the waste is necessary to avoid unwanted precipitation or gel formation in supernatants. Sludge washing and leaching performance and saltcake dissolution evaluations are based on empirical data extrapolated from individual tanks to groups of tanks based on waste types. Improvements in processing efficiency are expected if the wash, leach, and dissolution processes are based on an understanding of the dissolution thermodynamics and kinetics rather than just empirical data. Water usage and makeup chemical addition can also be reduced, which together with the improvement in efficiency, can reduce the amount of HLW glass produced.

Sludge Processing Scale-up and Process Improvement

At Hanford, currently sludge wash laboratory data to support delivery of feed for HLW immobilization in Phase IB Privatization are limited to that work done by the TFA for the HLW Project. This small-scale laboratory work is at the 5 gram/test level. Data are needed to support scaling the process up to full scale (5 x 109 g); an intermediate scale test (large bench-scale, small pilot-scale) involving about a 15-gallon-sized vessel and a few hundred gallons of actual waste would provide the appropriate scale-up information. Information is needed about the effects of temperature on such process steps as dilution and perhaps re-precipitation of solids, washing efficiency, leaching efficiency, and quantity of caustic needed. The various Privatization Phase I sludges need to be tested to support the full-scale processing planned for tanks 241-AZ-101, 241-AZ-102, and 241-AY-102 (including material retrieved from tank 241-C-106). Oxidation states of some of the chemical species (e.g., Cr) may need to be altered to ensure dissolution to support overall project objectives.

Baseline flowsheets for SRS and Hanford are based on batch-wise sludge processing in large vessels or in-tank. Although batch processes offer some advantages, e.g. simplicity, they also present potential problems, especially when applied on a large scale. Potential drawbacks include: poor efficiency because of heterogeneity and poor mixing and less ability to control mixing, mass transfer, heat transfer, and chemical kinetics. Continuous processing on the other hand, trades some additional complexity for significant benefits. Because the continuous process can be designed to maximize rate limiting processes, equipment sized to process an equivalent amount of waste in the same time can be processed in much smaller equipment than the corresponding batch vessels. Smaller equipment may result in reduced capital costs, less risk, better control, faster start-ups and

shutdowns, and less impact and faster recovery from process upsets. However, continuous processing of sludge has not been adequately developed or tested. Continuous processing of Hanford and SRS sludges may provide significant benefits; however, scale-up, demonstration, and evaluation of cost benefit is needed to fully evaluate the merits over the current batch processing baseline.

Path to Solution

Baseline Enhanced Sludge Washing

- Conduct laboratory-scale parametric testing of the baseline enhanced sludge washing flowsheets to evaluate separation efficiency for the remaining sludge types bounding the operating envelope.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
233	RL-TW06	Enhanced Sludge Washing	Engineering Development

- Evaluate caustic dissolution behavior of various Hanford sludge components to support the March 1998 Hanford TPA milestone and to recommend processing parameters for Phase I privatization (extended quantity order) and Phase II RFP decisions.

Sludge Washing Chemistry

- Evaluate Cr removal performance during sludge washing and identify methods (e.g., oxidative leaching and caustic leaching) to improve Cr removal

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
233	RL-TW06	Cr Oxidation	Advanced Development

- Develop treatment strategies to avoid solids formation through performance of caustic and acidic leach tests with Hanford sludges.

Sludge Processing Scale-up and Process Improvement

- Demonstrate settle-decant processing of Hanford sludges to obtain scale-up data and support Phase I privatization.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
233	RL-TW06	Settle Decant	Engineering Development

- Test and demonstrate continuous-flow sludge processing equipment as a higher efficiency alternative to the baseline batch processes for SRS.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
239	SR-HL04	Counter Current Decantation	Engineering Development

- Incorporate sludge processing performance data and lessons learned into the pretreatment analysis tool to support site decision making.

FY98-FY00 Scope and Schedule

Baseline Enhanced Sludge Washing - Work activities to address baseline ESW performance as a function of temperature and caustic concentration will include

- Parametric studies of ESW to support improved dissolution.
  - Complete parametric tests of two Hanford sludges to evaluate temperature and caustic concentration dependence. Support M-50-03 milestone with two additional sludge types. Evaluate dilute hydroxide and caustic leaching performance (FY98, TFA & EM-30).
  - Complete final parametric tests of caustic leaching with two additional Hanford sludges to support Phase II RFP development (FY99, TFA & EM-30). Decision point for engineering development.

Sludge Washing Chemistry - Work activities to support resolution of Hanford's Cr removal issues and prevention of solids formation in sludge washing solutions will include

- Alternative Alkaline Washes for Cr Removal Evaluation.
  - Develop test plan for Cr-oxidation studies and conduct lab-scale Cr leaching tests on three Hanford tank sludges (FY98, TFA & EM-30).
  - Conduct final two lab-scale Cr-leaching tests on Hanford tank sludges (FY99, TFA & EM-30). Decision point for engineering development.
  - Define functions and requirements for a bench-scale Cr leaching unit, design and procure system (FY99, TFA & EM-30).
  - Complete bench-scale Cr-leaching tests on two Hanford sludges and report on performance of system (FY00, TFA & EM-30). Decision point for demonstration.
- Prevention of solids formation in ESW
  - Complete caustic leach tests with four Hanford sludge samples and acidic leach tests with two Hanford sludge samples to evaluate solids formation issues (FY98, TFA & EM-30).
  - Evaluate ESW performance and processing options. Report on merits of options and recommendations for avoidance of solids formation (FY98, TFA & EM-30).
  - Complete tests of ESW using process control options to avoid solids formation. Verify performance of process control options for ESW (FY99, TFA & EM-30).
  - Complete non-ESW acidic leach tests and evaluate performance and process options. Report on merits of options and recommendations for avoidance of solids formation during acidic leaching (FY99, TFA & EM-30). Decision point for engineering development.

Sludge Processing Scale-up and Process Improvement - Work activities to support scale-up of sludge processing at Hanford and continuous sludge processing at SRS will include

- Settle-decant testing to support Hanford Phase I Privatization.
  - Complete ESW and nine settling tests on each of two Hanford sludges using engineering-scale equipment. Vary temperature and solids concentration to evaluate performance of ESW and settle-decant at a larger scale (FY99, TFA & EM-30).
  - Complete final two ESW and settle-decant runs with Hanford sludges. Report on performance of the process at the engineering scale to support Phase I privatization operations and Phase II RFP development (FY00, TFA & EM-30). Decision point for demonstration.
- Pilot-scale sludge processing to support Hanford Phase I and II Privatization.
  - Complete Engineering Analyses and develop preliminary design concepts for a sludge pretreatment CPU or pilot-scale module to support scale-up for sludge processing at Hanford (FY99, TFA & EM-30).

- Complete final design and fabrication of a pilot module. Develop infrastructure to support sludge retrieval and delivery to the pilot system (FY00, TFA & EM-30). Decision point for demonstration.
- Conduct cold shakedown testing of the sludge processing pilot system and initiate hot operation using Hanford sludges. Support Phase I privatization extended quantity order and phase II privatization RFP development (FY01, TFA & EM-30).

- Counter-Current Decantation for improved SRS sludge processing.
  - Complete cost savings evaluation and initiate vendor manufacture and testing of a full-scale (7' diameter) single settling CCD unit. Develop initial design concept for future deployment at SRS (FY99, TFA, EM-30, and EM-50 Industry Programs).
  - Conduct necessary settling studies on actual waste to support scale. Develop plans for siting the unit within the SRS tank farm (FY99, TFA, EM-30, and EM-50 Industry Programs). Decision point for demonstration.
  - Develop design specifications for procurement of a multi-stage CCD system. Initiate procurement and site preparation for demonstration (FY00, TFA, EM-30, & EM-50 Industry Programs).
  - Fabricate and cold test CCD system. Install system within tank farm for hot operations. Initiate demonstration of multi-stage CCD sludge processing system (FY01, EM-30 & EM-50 Industry Programs).

Other Related Work

- HLW Sludge Washing Monitors (CMST: FY98, $350K)
- Chemical Speciation of Strontium, Americium, and Curium in High Level Waste: Predictive Modeling of Phase Partitioning During Tank Processing (EMSP: FY96, Pacific Northwest National Laboratory)
- Enhanced Sludge Processing of HLW: Hydrothermal Oxidation of Chromium, Technetium, and Complexants by Nitrate (EMSP: FY96, Los Alamos National Laboratory)
- Collodial Agglomerates in Tank Sludge: Impact on Waste Processing (EMSP: FY96, Pacific Northwest National Laboratory)
- Acid-Base Behavior in Hydrothermal Processing of Wastes (EMSP: FY96, University of Texas at Austin)
- Processing of High Level Waste: Spectroscopic Characterization of Redox Reactions in Supercritical Water (EMSP: FY96, Furman University)
- Phase Chemistry of Tank Sludge Residual Components (EMSP: FY97, Sandia National Laboratories, $1,157K)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	2625	4500	2600
EM-50 Crosscut Programs	350		
EM-50 Industry/University/International			
EM-30/40			
Total	2975	4500	2600

Problem Element Title: 1.2.2.8 Prepare Pretreated Waste for Immobilization

Problem Element Description

Following pretreatment operations, supernate and sludge waste streams are transferred to HLW and LLW immobilization operations. A processing step may be required immediately following the radionuclide separation or sludge processing operations to ensure that the waste streams are acceptable for the immobilization unit operations. Processing may include additional volume reduction such as recycling, evaporation, or concentration to produce a stream more amenable to immobilization, or of reduced volume to decrease the quantity of waste requiring immobilization.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary SR-2020	632	SRS	Process Improvements to Maximize Saltstone Waste Loading
SR-2025	637	SRS	Caustic Recovery & Recycle
SR-2016	628	SRS	Demonstrate STPB Hydroxide Flowsheet to Reduce Nitrite Addition, Thereby Reducing ITP Washing Requirements
PW3	668	Hanford	Advanced Methods for Achieving LLW Volume Minimization

Problem Statement

The volume and toxicity of pretreated waste being transferred for LLW immobilization could be reduced through a number of process options.

Pretreated alkaline supernate containing large volumes of sodium nitrate and sodium hydroxide is sent to LLW immobilization processes. Nitrate concentration impacts the volume of LLW, because it is one of the chemical species driving waste form performance requirements. In addition, sodium hydroxide levels increase volume and could be reduced through recycle back to the processing facilities. At SRS, large quantities of chemicals (chiefly sodium salts of nitrate, nitrite, hydroxide, and aluminate) are present in the liquid phase of HLW. Greater than 99.9% of the soluble salts will be disposed in saltstone after removal of radioactive species in the ITP process. Recovery of sodium hydroxide (caustic) from the salt solution could significantly reduce the volume of waste disposed in saltstone. Recycling caustic also reduces the quantity of new chemicals added to the HLW system at the SRS. The recovered caustic could be used to neutralize fresh waste from the Separations

canyons, DWPF, and the Effluent Treatment Facility, used as a corrosion inhibitor in the Tank Farm, and used to dissolve alumina in Extended Sludge Processing (ESP).

At Hanford, the volume of tank waste is so large that enormous quantities of immobilized low activity waste will be generated and require appropriate LLW disposal. By removal of essentially nonradioactive constituents from the waste through innovative chemical processes, the volume of LLW requiring disposal could be significantly reduced. Like SRS, recovery of sodium hydroxide from the Hanford salt solutions could significantly reduce the volume of LLW produced.

In addition to high levels of sodium and nitrate, current separations at SRS leaves a LLW feed stream with a higher water content than is necessary for effective saltstone production. A reduction in this water content could significantly reduce the volume of LLW saltstone formed while maintaining a quality LLW product.

Path to Solution

- Evaluate salt splitting and membrane separation for caustic recovery for use at SRS and Hanford and explore commercial equipment for design and cost analysis.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
885	RL-TW06/07 SR-HL08	Caustic Recovery	Engineering Development
		Clean Salt	Advanced Development

- Design and procure commercially available equipment for out-of-tank evaporation of the saltstone feed stream at SRS to decrease the volume of immobilized LLW produced.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
20	SR-HL08	Out-of-Tank Evaporator	Demonstration

FY98-FY00 Scope and Schedule

Out-of-Tank Evaporator for SRS Saltstone Volume Reduction - Work activities to address SRS's need to maximize saltstone waste loading will include

- Design, fabricate, test, and deploy an OTE for SRS saltstone feed volume reduction.
  - Develop performance specifications for an industry RFP. Evaluate potential design constraints resulting from LLW feed compositions and conduct limited testing to resolve issues (FY98, TFA & EM-30).
  - Complete evaporator facility study defining facilities, support systems, documentation, and installation requirements and costs (FY98, TFA & EM-30). Decision point for Industry procurement.
  - Solicit industry to fabricate an OTE CPU system. Select vendor and initiate contract for design and fabrication. Decision point for demonstration (FY98, TFA, EM-30, and EM-50 Industry Programs).
  - Fabricate OTE system and perform operational shakedown testing (FY99, TFA, EM-30, & EM-50 Industry Programs).

- Deliver OTE to SRS and install system within LLW Saltstone facility. Conduct demonstration to evaluate system performance (FY00, TFA, EM-30, and EM-50 Industry Programs). Decision point for implementation.

Caustic Recovery and Salt Splitting for LLW Minimization at SRS and Hanford - Work activities to address SRS and Hanford needs for LLW minimization through caustic or salt recovery will include

- Demonstrate and deploy Caustic Recovery system for SRS and Hanford LLW minimization.
  - Develop performance requirements for an industry solicitation to develop, demonstrate, and evaluate caustic recovery for DOE applications (FY98, TFA & EM-30).
  - Solicit industry and select vendor for Phase 1 cold demonstration and evaluation (FY98, TFA, EM-30, & EM-50 Industry Programs).
  - Complete cold simulant demonstration and evaluate economics for application of caustic recovery to SRS or Hanford LLW streams (FY99, TFA, EM-30, & EM-50 Industry Programs). Decision point for demonstration.
  - Initiate Phase 2 fabrication and hot demonstration contract. Construct pilot-scale caustic recovery system (FY00, TFA, EM-30, & EM-50 Industry Programs).
  - Demonstrate caustic recovery at SRS or Hanford for LLW minimization. Complete performance evaluation (FY01, TFA, EM-30, & EM-50 Industry Programs). Decision point for implementation.

Other Related Work

- Salt Splitting Using Ceramic Membranes (ESP: RL36C341, FY98, $300K)
- OTE Deployment for SRS (Industry Programs: FY98, $500K; FY99, $1025K))
- Caustic Recovery and Recycle (Industry Programs: FY98, $500K; FY99, $525K)
- Modular Evaporator System for Waste Volume Reduction in Tanks (Technology Deployment Initiative: FY97, Oak Ridge Operations Office)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	525	1430	1600
EM-50 Crosscut Programs	300		
EM-50 Industry/University/International	1000	1550	
EM-30/40			
Total	1825	2980	1600

Problem Element Title: 1.2.3.1.3 Immobilize LLW Stream

Problem Element Description

The LLW streams produced during pretreatment separation operations at each of the tank waste sites will require immobilization to produce an acceptable waste form for disposal. Each of the DOE tank waste sites are considering different immobilization and disposal options for LLW, ranging from grout to glass, and from on-site disposal to off-site transport.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary ID-2.1.07	647	INEEL	Immobilize ICPP Low Activity Wastes
TK-06	608	ORR	Oak Ridge National Laboratory Tank Sludge and Supernatant Immobilization

Problem Statement

The current baseline for LLW immobilization at SRS, ORR, and INEEL is grouting. The baseline for Hanford is being established based on performance requirements set forth in the privatization call for proposals. Glass waste forms are being considered for Hanford and for M Area sludges at SRS. At INEEL, high nitrate levels in LLW feed require development of an appropriate LLW grout formulation and/or denitration process to pretreat the LLW feed. A sound basis for selecting LLW waste forms and the data needed to make this selection would help DOE evaluate privatization proposals, support design decisions, and would provide stakeholders with better information for considering waste form options.

The current strategy for immobilization and disposal of ORR tank wastes is based on privatization. Expressions of interest and comments on a draft RFP for treatment of the MVST waste have been solicited from the private sector. The strategy is predicated on the ability of private vendors to reliably immobilize the waste into forms suitable for disposal at either the Nevada Test Site or the WIPP. It is anticipated that vendors are most likely to propose either grout or glass forms. Before the awarding of a contract with a private vendor, ORR will put additional wastes into the MVST, changing the average tank waste composition. In addition, ORNL has some ability to blend the waste, if desired. The impacts of these changes in composition on waste processing, waste form acceptability, waste form volume, and waste disposal costs have not yet been determined. Once the

impacts are known, they can provide crucial input to waste tank operators making decisions about waste movement and blending. They can also provide a frame of reference to ORR for use in judging the adequacy of private sector responses to the RFP.

At the INEEL, LLWs from the separations process will be acidic and high in nitrates, both of which are detrimental to grout chemistry. The LLW at other DOE sites is basic; therefore, their grout formulations are not applicable to ICPP LLW. Due to the high acidity and nitrates in the waste, waste conditioning is necessary prior to grouting. Grout formulation consists of blending and proportioning the waste with cements such as ordinary Portland cement, blast furnace slag, and coal power plant fly ash. Once the grout formulation is developed for a specific LLW stream, extensive waste form qualification is required to document grout stability and leach resistance. Waste form qualification includes compressive strength after initial curing, immersing, and thermal cycling and leach tests for radionuclides and hazardous components. This is an iterative research process between waste conditioning, grout formulation, and waste form qualification. Equipment is needed to condition the simulated waste, mix grout, prepare full-size waste forms, core drill waste form, and conduct thermal cycle tests.

Current research utilizes thermal calcination to solidify the waste and destroy the nitrates. This denitration process produces significant amounts of off-gas, which must be handled. Denitration equipment must be specified, procured, and tested. The corrosive nature of the off-gas must be investigated and materials of construction determined.

In addition to these needs for immobilization technology development and evaluation, Hanford and ORR also require waste acceptance criteria and testing methods for the selected LLW form. Problem Element 1.3.2 (Dispose of LLW) describes these related monitoring and control needs and their respective paths to solution.

Path to Solution

- Develop specifications/functional requirements for grout and glass waste formulations for ORR.
- Demonstrate and evaluate grout and glass waste forms for ORR.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
82	OR-38108	Grout & Glass Waste Forms	Engineering Development

- Test and evaluate grout formations for INEEL's high aluminum, zirconium, and sodium wastes.
- Develop and test thermal denitration to support improved grouting of LLW at INEEL.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
82	ID-HL03	Thermal Denitration	Engineering Development

FY98-FY00 Scope and Schedule

Work activities within the TFA are intended to provide processing data and product data (short-term acceptance testing and long-term performance testing) to allow the tank sites to reach well-thought out decisions on waste forms for these types of waste.

INEEL's ICPP Low Activity Wastes - Work activities to support INEEL's need to develop process data to support Title 1 design of their immobilization process for LAW will include

Problem Element Title: 1.2.3.1.3 Immobilize LLW Stream

- Development and testing of thermal denitration for LAW.
  - Determine optimum conditions for thermal denitration through laboratory studies (FY98, TFA & EM-30).
  - Develop energy and material balances for LLW denitration to support flowsheet development and system design. Develop chemistry models and Chem CAD process plant simulator model (FY98, TFA & EM-30).
- Evaluation of process equipment and recommendation of a preferred system for LAW denitration.
  - Determine suitable materials of construction through corrosion testing (FY98, TFA & EM-30).
  - Evaluate commercial systems for thermal denitration, including moving bed, fluidized bed, and rotary kiln calciners. Recommend preferred thermal denitration process for INEEL LAW (FY98, TFA & EM-30). Decision point for procurement of pilot-scale equipment.
- Demonstrate thermal denitration processing at the pilot-scale.
  - Procure commercial equipment for pilot-plant thermal denitration system (FY99, TFA & EM-30).
  - Complete pilot-plant installation at the ICPP (FY99, TFA & EM-30).
  - Test thermal denitration of INEEL LAW at the pilot-scale to confirm processability. Report on performance to support Title 1 design (FY00, TFA & EM-30). Decision point for demonstration.

ORR's Tank Sludge and Supernatant Immobilization - Work activities to support ORR's need for performance data on grout and glass waste forms to support privatization and processing decisions will include

- Completion of comparison of grout and glass waste form performance and costs for ORR wastes.
  - Demonstrate effective production of grout and glass waste forms for a wide range of ORR tank sludge compositions (FY98, TFA & EM-30).
  - Complete grout formulation studies to identify the upper limit of waste loading and assess the accuracy of surrogate waste test results compared to actual tank sludges (FY98, TFA & EM-30).
  - Evaluate life-cycle costs of grout and glass waste form production for ORR wastes to support privatization proposal evaluations and processing decisions (FY98, TFA & EM-30). Decision point for demonstration.

Other Related Work

- Idaho LAW Form (International Programs: AEA, FY98, $200K)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	2050	900	1150
EM-50 Crosscut Programs			
EM-50 Industry/University/International	200		
EM-30/40	1000	1000	1000
Total	3250	1900	2150

Problem Element Title: 1.2.3.2 Process HLW

Problem Element Description

Immobilization of the HLW streams at INEEL, SRS, and Hanford are required to produce an acceptable HLW form for final disposal. Calcine immobilization and vitrification are the baseline methods for HLW immobilization. In addition to the calcination and vitrification immobilization processes, this problem element addresses melter feed preparation, process monitoring, and process control methods to produce acceptable waste forms.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary SR-2024	636	SRS	Upgrade DWPF Liquid Level and Density Measurements
SR-2011	623	SRS	Optimize Waste Loading for DWPF Glass
SR-2021	633	SRS	Enhance Equipment Design and Operability of the DWPF Melter System; Improved Melter Pour Spout Cleaning Techniques
ID-2.1.08	649	INEEL	High Activity Waste Form
ID-2.1.12	642	INEEL	Denitrate and Solidify the High Activity Fraction
PW1	666	Hanford	Identification and Management of Chromium and Other Problem Constituents for HLW Vitrification
SR-2019	631	SRS	Alternatives for DWPF Melter Feed REDOX Adjustment
SR-2026	638	SRS	Alternate DWPF Canister Decontamination Techniques
SR-2012	624	SRS	Develop Lower Cost Higher Capacity Melters for DWPF which are Consistent with Remote Operability Requirements
SecondarySR-2022	634	SRS	Enhance Equipment Design and Operability of the DWPF Melter System; Characterize Causes of Pour Spout Pluggage
SR-2023	635	SRS	Enhance Equipment Design and Operability of the DWPF Melter System; Increase Melt Rate in DWPF Melter

Problem Statement

The baseline technology for HLW processing is vitrification at all of the tank sites with this process being operational at SRS. At SRS, methods that can reduce the cost of operation are being identified and evaluated. Cost reduction can occur through optimization of waste loading that reduces the number of glass logs produced, improvements in process equipment and materials of construction

that reduce maintenance and downtime by reducing corrosion or other materials failure problems. At the Hanford Site, optimized waste loading and melter selection are considerations for developing the baseline to support Phase II privatization, especially with regard to concerns about high chromium wastes and their compatibility with current melter designs and waste formulations. At INEEL, waste formulation for sodium-bearing waste and calcined wastes followed by melter testing is needed to meet an accelerated schedule for the ROD, and the FY00 Title 1 Design schedule. Corrosion of melter materials from the acidic wastes at the INEEL is a key issue that must be addressed with both formulation and materials development and testing.

Optimizing Waste Loading for Hanford & SRS

SRS's DWPF complies with Waste Acceptance Product Specifications and process control requirements by demonstrating, to a high confidence, that melter feed will produce glass meeting all quality and processing requirements. This method requires that uncertainties associated with sampling, sample analysis, and models used to estimate properties be determined and that sufficient allowance is made for these uncertainties when controlling feed composition.

The existing model for liquidus temperature has a large uncertainty associated with it, and its application has led to reduction in allowable waste loading. Some constraints on the application of the durability model can cause acceptable glasses to be rejected, because the durability is indeterminate (i.e., the applicability of the model is not certain). A new or improved version of existing property models for liquidus temperature and durability are needed. The model tolerances need to be identified. These models should be applicable to the entire range of plausible glass compositions produced from glass formers (frits) and washed sludge waste ("sludge only glass") or glass formers, sludge, and processed washed precipitate ("PHA" or precipitate hydrolysis aqueous).

In addition to liquidus issues at SRS, waste loading issues associated with Cr and glass phase separation have been identified at Hanford. Currently, HLW glasses are formulated to ensure that little or no insoluble phases exist in the HLW melter. Insoluble phases are caused by such problem constituents as chrome minerals, spinels, and noble metals. An alternative method for handling problem constituents in HLW glasses is needed. The volume of HLW glass that will be produced from the sludges at Hanford is dependent on the ability to solubilize or dilute problem constituents that make up a very small fraction of the overall waste. Minimizing the impact of the problem constituents is important for formulating a strategy and staging the wastes to be treated during the Phase II privatization effort. Diluting the problem constituents usually involves blending of waste types and/or increasing the volume of glass waste forms. Both of these alternatives are expensive. An alternative for handling problem constituents is to allow them to remain insoluble in the glass matrix. This approach is acceptable as long as the insoluble phase does not adversely affect the processing of the waste or the quality of the waste form. Usually, the concentration of the insoluble constituents in the final waste form would be very low (less than 2%). Information is needed on the technical viability of producing HLW glasses with insoluble phases.

Melter Pour Spout and Process Equipment Improvements for SRS

Pour Spout: The DWPF Melter pour spout accumulates glass and crystalline deposits in three areas. These deposits must be periodically removed from the pour spout to maintain melter operability. The deposits also result in further glass deposition and pluggage in the bellows assembly, which couples the glass receiving canister to the melter. The causes of this accumulation and pluggage must be characterized as a part of the effort to eliminate the problem. Improved cleaning techniques are required to remove these deposits from the pour spout, the cause of the pluggage needs to be identified, and inserts or process improvements need to be developed to reduce or eliminate the

problem for future melters. Suspected contributors to the problem include physical design, glass chemistry/redox, and melter/pour spout pressure control systems.

Melter Throughput and Equipment Cost: The DWPF Melter has been unable to sustain glass production at the reference rate of 228 lb/hr (8 lb/hr ft2). It is important to produce glass at that rate or above to meet production goals and work off HLW inventories within the projected time frame. Besides pour spout problems limiting throughput, melt rate is also an issue. Experience to date indicates that "foaming" at the glass/feedstock interface is contributing to the melt rate problem by limiting heat transfer from the glass to the feed material. The redox state of the feed/glass may be the cause. Viscosity of the glass and melting feed may also limit the melting rate.
In addition to throughput issues, the melter is one of the most expensive and most complicated components in the DWPF. In the future, it could also become the production rate limiting component in the plant. A simpler, lower cost melter could result in significant lower life cycle costs for the DWPF.

DWPF Canister Decontamination: There is a potential problem that at near design production rates the DWPF canister decontamination operation could limit plant operating attainment to less than the design 75%. Canister decontamination is a water-frit slurry blast technique that removes contamination and oxides from the entire canister exterior surface. The waste from this process is in two forms. An off-gas is routed to the facility vessel ventilation system and on to facility controlled ventilation exhaust. A water-frit slurry waste stream is pumped into the facility chemical process and fed into the vitrification process stream, to minimize liquid waste production. This coupling of canister decontamination with chemical processing is less than optimum and could limit production rates in the future. Technology development is desired in this area, with the objectives to

- Minimize actual decontamination time, as well as full cycle time between canister decontaminations
- Simplify decontamination system controls, regarding operations and maintenance functions
- Minimize gas and liquid waste
- Minimize cost
- Minimize or eliminate the couple between canister decontamination and chemical processing.

Melter Feed Improvements for SRS

DWPF uses formic acid as a reductant to adjust melter feed REDOX conditions. Its process performance is satisfactory, but hydrogen and ammonia are produced. DWPF has Technical Safety Requirements (TSR) and engineered controls in place to control this hazard, but the administration and equipment maintenance and operation is burdensome. DWPF can reduce operating risk and the level TSR control by eliminating hydrogen and ammonia production during feed preparation. An alternative to formic acid for adjusting the redox potential of melter feed so as not to produce hydrogen or ammonia is needed. This reductant must reduce mercury to its elemental form and not reduce noble metals or copper.

Process Monitoring & Control for SRS

The level and density of the contents (both homogenous and slurry) of DWPF process tanks are currently determined by measuring the pressure at several levels in the tanks. The differential pressures are then utilized to determine liquid level and/or liquid density. Knowledge of these variables is necessary for successful operation of the process. Many of the tanks contain solid slurries consisting of glass frit and HLW sludge solids. Nitrogen or air bubblers are a common means to determine pressure in aqueous tanks at various levels. Such devices have been

unsuccessful at DWPF because of pluggage caused by the solid slurries. Because of this, Holledge Gages have been utilized at DWPF with good success. The disadvantage of Holledge Gages are high cost (about $75-$100K) for a remote unit and relatively short useful life (estimated average 2 year life). The DWPF contains 8 remote Holledge gages. Estimated cost for replacement of Holledge Gages is about $500K/year. Improved methods for level and density monitoring are needed to increase useful life and reduce costs.

Feed formulation and Melter Equipment Improvements for INEEL

Technology is needed to develop a process that immobilizes the high-activity waste (HAW) fraction from INEEL's ICPP calcine dissolution and radionuclide separation operations. Vitrification is considered the "Best Demonstrated Available Technology (BDAT)" for immobilizing highly radioactive wastes. Precedents are established for the use of a vitrification process to immobilize highly radioactive wastes by the operation of the DWPF at SRS and the West Valley Demonstration Plant at the West Valley Site. Exact vitrification technologies from these sites cannot be transferred for use at the INEEL because of the unique composition of the HAWs. Thus variations in the vitrification process need to be incorporated to make the HAW "road ready" by year 2035 as required in Section E.6 of the Batt Settlement Agreement.

The initial major performance requirement for immobilization is to determine that the HAW composition can be vitrified. Thus vitrification formulation development must first be interfaced with separations development to demonstrate that the HAW product can be vitrified to a useful glass. This synergism may require not only alterations in the vitrification formulation, but also in the HAW product composition meaning consequent alteration of the separations process. Useful vitrification of the HAW product will be achieved when such a product meets all waste form performance specifications for repository storage as established in the 1993 DOE-EM Waste Acceptance Product Specifications (WAPS). The next major performance requirement is that a process must be developed to produce the acceptable vitrified product on a production scale. The product of this process must also meet all the performance specifications established in the WAPS. These include specifications for waste forms, canisters, canistered waste forms, quality assurance and, documentation.

Although vitrification of the INEEL's HAW is the BDAT, actual vitrification processing could take place either at the ICPP or at an off-site location. In the case that vitrification is performed off-site, a means of preparing the waste for transport between locations is needed. Therefore, a safe and transportable interim waste form needs to be developed to support an off-site final vitrification option for INEEL.

Path to Solution

- Optimize waste loading for components such as iron, aluminum, silicon, zirconium, and alkali cations in SRS and Hanford wastes and determine solubilities in glass of minor components such as chromium, phosphate, halides, technetium, and actinides to optimize waste loading of these components.
- Develop improved liquidus models to support increased waste loading at SRS.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
2009	SR-HL05	Optimized Waste Loading	Engineering Development

Problem Element Title: 1.2.3.2 Process HLW

- Establish glass compositions for INEEL's sodium-bearing and calcined wastes to avoid highly corrosive environments and produce acceptable waste forms.
- Test melters for use at INEEL to ensure compatibility of wastes and materials of construction.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	ID-HLW03	Acid Waste Vitrification	Engineering Development

- Develop and demonstrate equipment improvements such as melter pour spout, level and density monitors for process tanks, and canister decontamination techniques to reduce downtime and increase throughput of the DWPF.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	SR-HL05	Melter Pour Spout	Engineering Development
N/A	SR-HL05	Level & Density Monitor	Engineering Development

FY98-F00 Scope and Schedule

Optimizing Waste Loading for Hanford & SRS - Work activities to support SRS and Hanford needs for optimizing waste loading will include

- Development of liquidus, nepheline, spinel, and waste loading maximization data to support increased waste loading at SRS and Hanford.
  - Complete experimental and statistical evaluation of liquidus temperature data for a broad range of waste compositions applicable to DWPF and Hanford. Transfer data to support model improvement and waste loading increases for DWPF (FY98, TFA & EM-30). Decision point for demonstration.
  - Investigate spinel and nepheline formation and resulting impacts on HLW vitrification and durability of HLW glasses (FY99, TFA & EM-30).
  - Complete evaluation of tools for waste loading maximization and provide performance data on tests conducted for Hanford and DWPF glasses (FY00, TFA & EM-30). Decision point for demonstration.

Melter Pour Spout and Process Equipment Improvements for SRS - Work activities to support SRS needs in melter throughput will include

- Improve pour spout performance for DWPF.
  - Develop experimental apparatus to evaluate glass pouring over a knife edge. Collect data on glass pouring behavior (FY98, TFA, EM-30, and EM-50 University Programs).
  - Merge glass pouring data with theoretical "oil model" data to develop a theoretical basis for explanation of glass pouring behavior (FY98, TFA, EM-30, and EM-50 University Programs).
  - Design, assemble, and calibrate a testing system to simulate the temperature gradients, dimensions, and flow rates of the DWPF melter under non-radiological conditions (FY98, TFA & EM-30).
  - Complete initial operation of the test system. Investigate pour pluggage and spout flow characteristics. Evaluate two improved pour spout insert designs developed from glass pouring behavior model results (FY98, TFA & EM-30).
  - Evaluate commercial alternative heater materials and equipment. Downselect systems and demonstrate within the test system to evaluate performance and impact on pour spout flow

characteristics (FY99, TFA & EM-30). Decision point for pour spout design and heater system modifications to DWPF melter design. Decision point for demonstration.

- Enhance melter throughput and reduce equipment costs.
  - Identify alternative features needed to extend melter life and performance, including the melter, auxiliary support systems, and the offgas system. Identify advanced materials needs (FY99, TFA & EM-30).
  - Initiate collaborative development with industry, universities, and national laboratories to address priority features identified in FY99 (FY00, TFA & EM-30).
  - Evaluate feature improvements for consideration in design of future melters for DWPF (FY01, TFA & EM-30). Decision point for demonstration.
- Develop improved DWPF canister decontamination process.
  - Develop functional performance requirements for the canister decontamination system. Solicit commercial solutions and evaluate concept proposals (FY99, TFA & EM-30).
  - Select commercial vendor for development and adaptation of improved decontamination system for remote service (FY00, TFA & EM-30).
  - Complete system adaptation and shakedown testing (FY00, TFA & EM-30). Decision point for demonstration.
  - Demonstrate improved decontamination system for DWPF canisters. Evaluate performance (FY01, EM-30).

Melter Feed Improvements for SRS - Work activities to support SRS's need for improved melter feed REDOX adjustment will include

- Develop and demonstrate alternative process for REDOX adjustment and control
  - Solicit concepts to provide alternatives to formic acid REDOX adjustment. Review and evaluate proposals (FY99, TFA & EM-30). Decision point for engineering development.
  - Initiate development program with waste simulants. Evaluate ability of alternative REDOX agent to both destroy TPB precipitate and adequately adjust melter REDOX conditions (FY99, TFA & EM-30).
  - Develop flowsheet and performance data through laboratory-scale testing (FY00, TFA & EM-30). Decision point for demonstration.
  - Demonstrate alternative reductant flowsheet and improved REDOX control through pilot-scale reduction and melter testing (FY00, TFA & EM-30).

Process Monitoring & Control for SRS - Work activities to support SRS's need for improved level and density monitors will include

- Develop and demonstrate improved level and density probes for SRS applications within DWPF and ESP.
  - Conduct feasibility study on commercial level and density probes for application to DWPF process vessels and the ESP facility at SRS. Develop functions and requirements for each process application (FY98, TFA, EM-30, and EM-50 Industry Programs).
  - Complete cold feasibility tests with commercial capacitance probe for measurement of liquid and organic layer interface (FY98, TFA, EM-30, and EM-50 Industry Programs).
  - Develop acoustic-based level and density probe for SRS applications (FY99, TFA , EM-30, and EM-50 Industry Programs). Decision point for demonstration.
  - Demonstrate acoustic-based level and density monitors for applications at SRS (FY00, TFA, EM-30, and EM-50 Industry Programs). Decision point for implementation.

Feed formulation and Melter Equipment Improvements for INEEL - Work activities to support HAW immobilization for INEEL will include

Problem Element Title: 1.2.3.2 Process HLW

- Evaluate the impact of waste formulation on corrosion rate.
  - Develop process-corrosion rate relationship based on the glass formulation model. Assess the impact of formulation on melter corrosion (FY98, TFA & EM-30).
  - Conduct bench-scale melter runs based on process-corrosion rate relationships to support formulation development for INEEL (FY99, TFA & EM-30).
- Identify appropriate materials of construction to support Title 1 design for each INEEL HAW type.
  - Complete materials of construction testing for SBW HAW using crucible scale melter tests (FY98, TFA & EM-30).
  - Complete materials of construction testing for zirconia calcine HAW using crucible-scale melter tests (FY99, TFA & EM-30).
  - Complete materials of construction testing for alumina calcine HAW using crucible-scale melter tests (FY00, TFA & EM-30). Decision point for demonstration.
- Development and testing of an acceptable interim waste form for transport of HAW.
  - Develop test plan and agreements with the Russian Institute of Chemical Technology to demonstrate the Silica Gel technology for INEEL HAW (FY99, TFA, EM-30, & EM-50 International Programs).
  - Conduct laboratory-scale demonstration of the silica gel technology for immobilization of partitioned radionuclides (FY00, TFA, EM-30, & EM-50 International Programs). Decision point for engineering development.

Other Related Work

- DWPF Level and Density Monitors (Industry Programs: FY98, $200K; FY99, $200K)
- Superconducting Open-Gradient Magnetic Separation for the Pretreatment of Radioactive or Mixed Waste Vitrification Feeds (EMSP: FY96, Argonne National Laboratory)
- The Influence of Radiation and Multivalent Cation Additions on Phase Separation and Crystallization of Glass (EMSP: FY97, University of Arizona, $723K)
- Thermodynamics of the Volatilization of Actinide metals in the High-Temperature Treatment of Radioactive Wastes (EMSP: FY97, Lawrence Livermore National Laboratory, $900K)
- Radiation Effects on Transport and Bubble Formation in Silicate Glasses (EMSP: FY97, Argonne National Laboratory, $750K)
- Foaming in Radioactive Waste Treatment and Immobilization Processes (EMSP: FY97, Illinois Institute of Technology, $360K)
- New Silicotitanate Waste Forms: Development and Characterization (EMSP: FY97, Pacific Northwest National Laboratory, $1,200K)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	1710	2355	3200
EM-50 Crosscut Programs			
EM-50 Industry/University/International	200	200	
EM-30/40	800	900	1100
Total	2710	3455	4300

Problem Element Title: 1.3.1 Close Tanks

Problem Element Description

Closure of radioactive waste tanks requires sampling and/or characterization of waste tank residuals, definition of closure criteria (i.e., "how clean is clean?"), and stabilization of the tank "potentially including barrier technology." Stabilization of the tanks and installation of surface or subsurface barriers may be required following retrieval and post-retrieval characterization, in order to prevent subsidence of a tank, collapse of the domed top, long-term migration of residual contaminants, or short-term release of residual waste contents due to catastrophic failure. Stabilization may encompass grout filling to fill the tank and stabilize wastes, or a simple gravel fill to prevent tank dome collapse. Barrier technology may include engineered surface barriers to prevent water, plant, and animal intrusion, or subsurface barriers that prevent contaminants or moisture from migrating downward to the water table.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Primary ID-2.1.10	648	INEEL	Characterize Tank Farm Heels
ID-6.1.20	651	INEEL	Tanks- New 3 - In Situ Decontamination of Buried Tank Contents
TK-01	611	ORR	Oak Ridge National Laboratory Tank Waste Characterization
TK-09	612	ORR	Oak Ridge National Laboratory Tank Closure
TK-10	604	ORR	Oak Ridge National Laboratory Remediated Tank Isolation and Removal
Retr 1	679	Hanford	Establish Retrieval Performance Evaluation Criteria
SecondaryID-6.1.21	652	INEEL	Tanks - New 2 - Removal and Consolidation of Waste from Buried Tanks
ID-6.1.22	653	INEEL	Tanks - New 1 - In Situ Homogenization of Buried Tank Waste
ID-6.1.07	655	INEEL	In Situ Characterization of Tank Contents
ID-6.1.17	656	INEEL	Removal of Small to Medium Buried Tanks
SD4	687	Hanford	Long-Term Testing of Surface Barrier
SD5	688	Hanford	Testing of Sand-Gravel Capillary Barrier

Problem Element Title: 1.3.1 Close Tanks

Site Need Identifying #	TFA Response #	Site	Need Title/Description
Secondary SD6	689	Hanford	Moisture Dependence of Kd
SD7	690	Hanford	Getter Materials
SD9	692	Hanford	Field Measurements of Vadose Zone Hydraulic Properties
SD10	693	Hanford	Distribution of Recharge Rates

Problem Statement

Closure of radioactive waste tanks has become a key element in the tank sites' baseline plans for reducing mortgage and accelerating cleanup. SRS is actively closing tanks, while ORR and Hanford are preparing for future tank closure activities through the GAAT Treatability Study and the Hanford Tanks Initiative (HTI), respectively. INEEL is exploring an accelerated schedule for tank closure, and will be sampling tank residuals to support future closure decisions. Tank closure activities include sampling or characterization of tank residuals, defining the closure criteria (i.e., asking the question, "how clean is clean?", and stabilizing the tank for closure. These three aspects of tank closure are captured in TFA's problem elements 1.3.1.2, 1.3.1.3, and 1.3.1.7, but are summarized here at the upper problem element level of 1.3.1 Close Tanks.

Sample and Characterize Heels/Residual Waste

GAAT Tanks at ORR: ORNL has 50-year-old vertical concrete tanks. The largest tank is 50 ft. in diameter, 12 ft high at the walls, and 18 ft high at the dome. The tank is buried under approximately 6 f. of overburden, which is contaminated. After the sludges are removed, the amount of contamination in the concrete walls must be determined before closure requirements can be defined. Tools are needed to collect gunite wall samples for analysis of residual contamination prior to closure.

AX-104 at Hanford (HTI): Methods are needed to sample the residual waste for use in establishing retrieval performance evaluation criteria. Conventional sampling methods for residual waste can prove ineffective due to little or no waste being located directly below the access riser. In addition, enough locations in the tank need to be sampled to show adequate characterization of residual waste for use in tank-specific performance assessment work. Sampling tools that can collect off-riser samples for analysis are needed. In addition, vadose zone sampling is required to quantify source term from leaked waste.

ICPP Tanks at INEEL: When the ICPP high-activity tanks are emptied, a heel may remain. It is proposed to grout any such heel in place upon tank closure. Technology is required to characterize tank farm heel residuals to allow development of grout formulations as well as assess residual radionuclide activity. The heel characterization must take place in highly radioactive and limited access environments. Methodologies and platforms for deploying heel sample retrieval equipment are also needed for heel mixing, hose deployment, ventilation, shielding, containment, heel sampling, etc.

Establish Closure Basis

Retrieval Performance Criteria for Hanford (HTI): Other than the retrieval performance goal provided in the TPA which is recognized by the Washington Department of Ecology and DOE in a memorandum of understanding as only an "interim" goal, no basis currently exists for defining

retrieval performance objectives that address how much waste must be removed from SSTs and how much leakage during retrieval of SSTs will be allowable. Several discrete technology needs must be satisfied to support decisions for tank closure alternatives. These needs include

- Improvements to equipment and methods for tank heel removal (described in problem element 1.2.1.2)
- Conditioning of wastes to slurries acceptable for transport (described in problem element 1.2.2.3)
- Techniques to measure the residual waste volume following retrieval efforts
- Methods to capture samples of waste that are not directly below the riser (described in this problem element under "sample & characterize heels")
- Methods to map contaminants in the vadose zone.

Data addressing these needs must then be incorporated into performance evaluation modeling tools, evaluated, and discussed with stakeholders and regulators to define the performance criteria for tank waste retrieval and ultimate closure.

Parameters Influencing Performance Evaluations: To ensure adequate predictions of long-term performance of stabilized and closed tanks or immobilized LLW (see problem element 1.3.2 Dispose of LLW), adequate modeling of fate and transport is required. A number of issues impact the accuracy of fate and transport modeling, especially in arid western environments such as Hanford. These issues revolve around the dependence of contaminant migration on the related parameters of vadose zone soil moisture content, hydraulic properties of the soil, and water recharge rates. Uncertainties exist in our current understanding and estimation of these parameters. Therefore, a number of related needs exist that, if addressed, would allow for improved performance evaluations to support tank closure and waste form disposal. Specifically, issues include

- Liquid and vapor flow in unsaturated soils: Moisture flow is the driving force for contamination release from waste and the transport of the contaminants. This flow is poorly understood under the arid conditions frequently found in arid Western sites. In particular, for those sites where moisture barriers or diverters are, the theory and parameters describing liquid and vapor flow under very dry conditions need to be better understood.

- Recharge rates: Recharge water is the primary means for dissolution and release of contaminants from the buried waste and transport of those contaminants to the groundwater. Estimation of these rates is difficult under arid conditions because the rates are very low. In addition, there are significant questions about the adequacy of the estimated recharge rates given the heterogeneity of the environmental processes, the effect of facility features, the uncertainty of climate, and the influence of humans. Quantification of the distribution of recharge rates to enable sounder estimates of the mean and range of rates to be expected during the lifetime of the facilities are needed.

- Contaminant adsorption/retardation: Contaminants interaction with the soil can greatly delay and diminish the contaminant transport. For example, Hanford studies have shown a moisture dependency of uranium adsorption to soils. More recent research has shown that the degree of uranium adsorption may increase or decrease, depending on the soil type, as soil moisture increases. The relationship of the uranium adsorption to soil moisture content is needed to support performance assessment efforts.

- Accurate measurement of hydraulic properties: Assessments of waste disposal require the knowledge of hydraulic properties in the unsaturated sediments (the vadose zone). Typically, these properties are inferred or estimated from small cores or particle size distributions obtained from a drilled borehole. Field measurements of hydraulic properties will eliminate the uncertainty when extrapolating small-scale laboratory measurements.

Stabilize Tank for Closure

GAAT tanks at ORR: Old deteriorating waste storage tanks exist that contain sludge heels that have been determined to be of negligible risk to health, safety, and environment. However, it will be very costly to remove the waste from tanks with limited access ports. Residual waste in the concrete walls and liners of the waste tanks may also dictate the need for tank closure. A technology is needed to stabilize these sludge heels in situ as part of tank closure. Fill material that can meet acceptance criteria for tank closure is also required. Tank closure systems are needed and must include

- Equipment to fill tanks, piping and systems
- Monitors to control the filling process
- Monitors to verify the filled tank system.

V-tanks at INEEL: Unlike the HLW tanks at Hanford, SRS, and INEEL, or the TRU waste tanks at ORR, which are pursuing in situ stabilization options for tank closure, INEEL also currently has 11 buried waste tanks (V-tanks) containing TRU and mixed waste for which tank removal is being pursued as the method to obtain site closure. Tanks range from 100 to 50,000 gallons. There will be more tanks identified for remediation at the INEEL over the next several years. These tanks are being remediated through the CERCLA process. The latest date that information derived from technological development would be useable for the INEEL Remedial Investigation/Feasibility Study (RI/FS) is October 1, 1998. The waste tank removal efforts require technology support in a number of areas including waste mixing, waste removal, decontamination, and tank removal.

- Waste Mixing: A remotely operated mixing system is required to homogenize tank contents to allow the contents to be pumped from the tank. Mixing equipment must be able to homogenize the entire tank contents, including sumps. Direct access to the tank may be up to 200 feet from the end of the tank. The technology must be capable of mixing the contents in the presence of internal baffles and flanges.

- Waste Removal: A method is needed for the removal of waste from buried tanks including consolidation of waste between tanks, without release of contaminants to the environment. Tanks range from 100 to 50,000 gallons. The method should be capable of being remotely operated.

- Decontamination: A method is needed to in situ decontaminate buried tanks, including capability of removing small, heavy particles lying on the bottom of tanks (i.e., not suspended in the slurry or sludge). Method should be able to perform at distances of up to 50 feet from tank openings and from regions of the tanks with restricted access, and in sumps or baffles.

- Tank Removal: A method is needed for the removal of 11 buried waste tanks and potentially contaminated soils, containing TRU and mixed waste, without release of contaminants to the environment. Tanks range from 100 to 50,000 gallons. The method should cause minimal risk of damaging the object being excavated, buried piping, or cable runs, and it should be capable of being remotely operated.

Problem Element Title: 1.3.1 Close Tanks

Path to Solution

Sample & Characterize Heels

- Deploy the LDUA at INEEL to sample tank residuals and support strategy development for accelerated tank closure.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
85, 810, 835	ID-HLW03	LDUA	Implementation
N/A	N/A	Gripper End Effector	Implementation
278	N/A	NDE End Effector	Demonstration
N/A	N/A	Stereo Video Camera End Effector	Implementation
860	N/A	Sampler End Effector	Implementation

- Develop a wall coring tool to sample the gunite tank walls at ORR to support GAAT closure demonstration.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	OR-43203	GAAT Wall Coring Tool	Demonstration

- Deploy the LDUA and gripper end effector to move currently used sampling devices to off-riser locations in Tanks 104-AX and 106-C to sample tank residuals and support retrieval performance criteria development within the HTI.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
85, 810, 835	N/A	LDUA	Implementation
N/A	N/A	Gripper End Effector	Implementation

- Develop and demonstrate vadose zone characterization tools for the cone penetrometer to support tank farm closure performance evaluations and development of retrieval performance criteria within the Hanford Tanks Initiative.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	RL-TW01	Cone Penetrometer	Implementation
N/A	N/A	CPT Integrated Sampler/Sensor System	Engineering Development

Establish Closure Basis

- Conduct performance assessment through application of fate and transport models, integration of AX-104 and vadose zone characterization data, and tank stabilization alternatives to develop retrieval performance evaluation criteria.

Problem Element Title: 1.3.1 Close Tanks

Stabilize Tank for Closure

- Develop and deploy tools using the LDUA to isolate and plug tank penetrations (e.g., piping).

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	OR-43203	Pipe Plugging Tool	Engineering Development
N/A	OR-43203	MLDUA	Implementation

- Develop, test, and deploy grout formulations and jet grouting techniques to stabilize gunite tanks at ORR and close the North and South Tank farms.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
N/A	OR-43203	Multiport Grout Injection	Engineering Development

FY98-FY00 Scope and Schedule

Sample and Characterize Heels

GAAT Tanks at ORR - Work activities to support ORR's need for characterizing the GAAT tank for closure will include

- Develop a wall coring tool to sample the gunite tank walls at ORR to support GAAT closure demonstration.
  - Define functions and requirements for the Gunite Tank coring tool (FY99, TFA & EM-40).
  - Fabricate and cold test coring tool (FY99, TFA & EM-40).
  - Integrate coring tool with the Modified Light Duty Utility Arm (MLDUA) and end-effector systems such as the camera, lights, and gross-gamma probe (FY99, TFA & EM-40).
  - Deploy the coring tool and obtain samples from the gunite tank walls to support closure decisions (FY99, TFA & EM-40). Decision point for implementation.

Waste Volume Estimates for Hanford (HTI) - Work activities to support Hanford's need for characterizing the tank residuals in and around AX-104 and C-106 will include

- Conduct AX-104 in-tank residual waste volume assessment and sampling to determine if residual wastes can meet retrieval performance objectives.
  - Complete AX-104 Auger Sampling campaign for "on-riser" initial residual samples (FY98, TFA & EM-30.
  - Complete adaptation of available sampling tools to the LDUA gripper end effector to support off-riser sample collection (FY98, TFA & EM-30).
  - Deploy the LDUA in AX-104 and collect off-riser waste residual samples (FY98, TFA & EM-30).
  - Complete waste volume estimation based on AX-104 sampling and assessment efforts (FY98, TFA & EM-30).
- Conduct C-106 waste volume measurement and assessment.
  - Deploy LDUA in C-106 and collect off-riser waste residual samples (FY01, TFA & EM-30).
  - Complete waste volume estimation based on C-106 sampling and assessment efforts (FY01, TFA & EM-30).
- Development and deployment of vadose zone characterization tools for the cone penetrometer to obtain data to support performance assessment efforts.
  - Develop an integrated Cone Penetrometer (CPT) sensor and sampling system for radionuclide and metal sensing and soil sampling (FY98, TFA & EM-30).

- Conduct cold CPT and sensor/sampler deployment in Hanford soils to evaluate deployability and operability (FY98, TFA & EM-30).
- Deploy the CPT sensor/sampler system at AX-104 to collect vadose zone characterization data to support retrieval performance criteria evaluations (FY98, TFA & EM-30). Decision point on implementation.

INEEL Tank Heel Sampling - Work activities to support INEEL's need for sampling the HLW tank heel will include

- Deploy the LDUA at INEEL to sample tank residuals and support strategy development for accelerated tank closure.
  - Design balance of plant hardware including interface between INEEL LDUA and tank riser, utility skids, containment module, and control trailer (FY98, TFA & EM-30).
  - Complete fabrication and pre-test of balance of plant hardware. Integrate hardware and pre-test system for operability and performance to specifications (FY98, TFA & EM-30).
  - Issue tank waste heel sampling plan and complete readiness assessment (FY98, TFA & EM-30). Decision point on implementation.
  - Deploy LDUA and retrieve HLW tank heel samples to support tank closure assessment efforts (FY98, TFA & EM-30).

Establish Closure Basis

Hanford Tanks Initiative - Work activities to support Hanford's need for establishing retrieval performance criteria will include

- Establish retrieval performance evaluation criteria and evaluate retrieval and closure alternatives for AX-104 and C-106.
  - Develop engineering data on retrieval and closure alternatives and conduct modeling to support risk assessment (FY98, TFA & EM-30).
  - Adapt fate and transport models and integrate preliminary vadose zone characterization data to assess potential health risks. Conduct sensitivity analysis of model predictions as a function of parameters (FY98, TFA & EM-30).
  - Update model with tank residual estimates, final vadose zone characterization data, and retrieval and closure engineering alternatives. Evaluate potential health risks for each alternative and compliance with federal and state requirements. (FY98, TFA & EM-30)
  - Evaluate alternatives and potential risks with stakeholders to identify retrieval and closure alternatives to continue to be pursued (FY98, TFA & EM-30).

Tank Site Closure Technology for Hanford - Work activities to support Hanford's needs for improved data and understanding of vadose zone moisture and contaminant transport will include

- Identification of the important parameters (such as hydraulic conductivity, diffusion coefficients, effective porosities, etc., by radionuclide species) for determining liquid and vapor phase moisture flow in arid conditions.
  - Review state of understanding of moisture flow in arid soil. Evaluate existing simulation codes and select the baseline analysis tool (FY99, TFA & EM-30).
  - Perform sensitivity analyses with this baseline tool to determine key flow parameters to be evaluated and measured. Develop program plan to guide priority testing/assessment efforts (FY99, TFA & EM-30).
- Measurement and simulation of parameters over a wide range of potential environments for a variety of potential closure materials such as sand, gravel, concrete, grout, etc.
  - Evaluate the impact of flow parameters, through laboratory testing and simulation on retrieval performance criteria for HTI. Assess the uncertainty in these parameters and their

impact on the HTI performance assessment efforts (FY00, TFA & EM-30).

- Performance of laboratory and field tests to verify simulations and key parameters.
  - Establish field test plan and equipment to determine actual flow parameters for the Hanford Vadose zones and compare with previous laboratory results (FY01, TFA & EM-30).
  - Complete performance evaluations using both field and laboratory results to understand impact of test results on HTI closure activities (FY01, TFA & EM-30). Decision point on demonstration.

Stabilize Tank for Closure

GAAT tanks at ORR - Work activities to support ORR's needs for GAAT tank closure technology will include

- Develop and deploy tools using the LDUA to isolate and plug tank.
  - Complete pipe plugging functional requirements and specifications for GAAT closure (FY98, TFA & EM-40).
  - Fabricate GAAT pipe plugging tool and complete cold testing (FY98, TFA & EM-40). Decision point for demonstration.
  - Deploy pipe plugging system in initial GAAT tank to prepare for in-tank stabilization campaign (FY99, TFA & EM-30). Decision point for implementation.
- Develop, test, and deploy grout formulations and jet grouting techniques to stabilize gunite tanks at ORR and close the North and South Tank farm.
  - Complete initial functional requirements and specifications for stabilization of GAAT tanks (FY98, TFA & EM-40).
  - Conduct grout equipment and grout physical performance tests (FY98, TFA & EM-40).
  - Complete grout tests with simulated and actual sludge materials to ensure performance of the LLW form (FY98, TFA & EM-40).
  - Establish grout performance and grout emplacement specifications and requirements (FY98, TFA & EM-40).
  - Procure grout delivery/emplacement system (FY99, TFA & EM-40). Decision point for demonstration.
  - Complete cold performance verification of the in-situ grouting system (FY00, TFA & EM-40).
  - Deploy the grout delivery system. Complete initial in-situ grouting campaign and evaluate performance (FY00, TFA & EM-40). Decision point for implementation.

V-tanks at INEEL - Work activities to support INEEL's needs for technology to support V-Tank remediation will include

- Adaptation, development, testing, and deployment of integrated systems for closure of INEEL's V-tanks.
  - Establish functional requirements for major subsystems to be deployed into the tanks for waste characterization, mixing, retrieval, and decontamination (FY99, TFA & EM-40).
  - Initiate procurement of equipment for remediation of tanks (FY99, TFA & EM-40).
  - Complete procurement of equipment for buried tank remediation activities. Perform integrated cold tests of the equipment prior to hot deployment (FY00, TFA & EM-40).
  - Complete Operational Readiness Review and document operational strategies for characterization, consolidation, and homogenization as well as retrieval and tank removal for closure. (FY00, TFA & EM-40). Decision point for hot deployment of characterization and retrieval system.
  - Transfer system from cold test facility to first buried waste tanks for remediation (FY00, TFA & EM-40).

Problem Element Title: 1.3.1 Close Tanks

- Complete first remediation of buried waste tank. Verify that performance criteria for characterization, retrieval, grouting, decontamination of tanks, and tank removal have been met (FY01, TFA & EM-40). Decision point for multi-tank implementation.

Other Related Work

- HTI Plume Characterization (CMST: FY98, $600K)
- Mineral Surface Processes Responsible for the Decreased Retardation (or Enhanced Mobilization) of ^{137}Cs from HLW Tank Discharges (EMSP: Pacific Northwest National Laboratory, $1,250K)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	10570	12600	13550
EM-50 Crosscut Programs	600		
EM-50 Industry/University/International			
EM-30/40	10105	8000	7000
Total	21275	20600	20550

Problem Element Title: 1.3.2 Dispose of LLW

Problem Element Description

The immobilized low-activity or low-level waste (ILAW) from grouting operations at SRS, ORR, and possibly INEEL or vitrification operations at Hanford will require, in most cases, on-site disposal. To ensure the waste form meets disposal requirements, regardless of the specific waste form selected by the site for use, process monitoring and/or product assessment is required. In addition, LLW disposal will require performance assessment (see related discussion in problem element 1.3.1 - Close Tanks) and consideration of surface and subsurface engineered barriers to ensure the immobilized LLW disposal site meets performance requirements. Barrier technology may include engineered surface barriers to prevent water, plant, and animal intrusion, or subsurface barriers that prevent contaminants or moisture from migrating downward to the water table. This problem element addresses both ILAW product acceptance testing and ILAW disposal facility engineering.

Priority Site Needs

The FY97 site needs assessment identified site needs within this problem element. Work activities have been proposed to directly address these specific need(s). These are identified in the table below as "primary" needs, and indicate that work activities will a) be closely coordinated with the cognizant engineers or technical points of contact at the identified site, b) likely involve use of actual waste from that site, and c) result in products that will feed directly into the sites' technical and programmatic decisions. Work activities addressing a primary need may also indirectly benefit related TFA site needs. These are identified in the table below as "secondary." These activities will potentially provide valuable lessons learned and performance data that can aid in the sites' technical planning and scope development; however, the work activities are not likely to provide results or data on site-specific wastes that could definitively support technical decisions. In addition, secondary needs include prior years' site needs for which technical responses were initiated and activities are still underway to address. These past needs are included for reference and completeness. The primary needs being addressed and the secondary needs being partially supported within this problem element include

Site Need Identifying #		TFA Response #	Site	Need Title/Description
Primary	PW10	675	Hanford	ILAW Product Acceptance Inspection and Test Methods
Secondary	PW4	669	Hanford	Formulation of Reference Glass for Immobilized LAW
	PW11	676	Hanford	IHLW Product Acceptance Inspection and Test Methods
	PW12	677	Hanford	Secondary Products Acceptance Inspection and Test Methods
	SD2	685	Hanford	Standard Method for Determining Waste Form Release Rate
	TK-06	608	ORR	Oak Ridge Tank Sludge and Supernatant Immobilization

Problem Statement

Disposal of ILAW requires both assurance that the waste form meets requirements, and that the disposal site is designed appropriately with adequate information to complete a performance assessment, and adequate barrier technology included to minimize long-term contaminants. Needs exist for both product acceptance testing to ensure the LLW immobilization process works, data collection to support performance assessment efforts, and evaluation of disposal site barrier technologies to ensure the final disposal of the ILAW meets requirements.

Problem Element Title: 1.3.2 Dispose of LLW

ILAW Product Acceptance

Product quality assurance is a necessary step in the LLW immobilization process. The baseline LLW immobilization technology for INEEL, and SRS is grout and saltstone, respectively, while Hanford is pursuing a glass waste form as part of privatization. Grout and glass waste forms are being evaluated for ORR (see problem element 1.2.3.1.3). While product quality assurance is well established for the HLW glass at SRS's DWPF, and for the LLW saltstone at SRS, LLW glass for Hanford still requires product quality assurance methods and waste form performance testing to allow for LLW disposal preparations and receipt of LLW glass product from the privatization vendors. Specific needs include

- Reference glass for ILAW: A standard reference material for ILAW applications must be identified for use in inter- and intralaboratory comparisons between the private contractor and DOE to verify the accuracy of reported results. The identification, development, and qualification of ILAW form reference materials is required. These materials must have appropriate compositions typical of expected ILAW forms so that the reference materials have utility for verifying ILAW compositional and durability specifications and comparing inter- and intralaboratory test results.

- Product Acceptance Inspection and Test Methods: Under the privatization (Phase I) efforts at Hanford, DOE will provide tank wastes to the private contractors who will treat and immobilize the wastes and then return the final products to DOE for storage and final disposal. DOE will pay the private contractors for each waste package received that meets the product specifications. Acceptance of the immobilized wastes will be based on a combination of private contractor activities to qualify, verify, document, and certify the product and DOE activities to audit, review, inspect, and test the processes and products. The DOE may conduct non-destructive testing of the sealed immobilized waste containers and destructive and non-destructive testing of the process and product samples. Specific parameters of interest may include chemical composition of the waste forms, fillers, and containers phase composition, radiochemical composition thermal history and surface temperature, waste form volume and void space, waste form and container weight container dimensions, including wall thickness effectiveness of container closure or seal (leak tightness), presence of prohibited materials including free liquids and explosive, pyrophoric or combustible materials, dose rate, surface contamination, waste form homogeneity, and waste form release rates. Generally, the inspection and test methods should not require opening or otherwise breaching the seal of the waste form containers. Appropriate sampling and analysis strategies need to be developed to provide the basis for making statistically based statements with respect to the confidence with which the products meet specifications.

Performance Assessment of the ILAW

- Waste Form Release Test: The release of radionuclides from a waste form and package to the environment results from the interactions between the waste form and water in the disposal system. Waste forms are typically developed to minimize the rate of release as measured by a variety of test methods. Current ILAW product specifications require PCT testing and ANS 16.1 testing of the waste forms. These test methods may not be representative of the expected disposal system environment at Hanford. A release rate test method yielding results that can be related to the waste form release rate under expected service conditions is needed as a basis for Phase II privatization ILAW product specifications and to support the performance assessment efforts need for ILAW disposal for Phases I and II.

- Waste Glass Surface Area: The contaminant release rate from glasses is proportional to the surface area reachable by moving moisture. As glass cools it experiences internal stresses and strains, which may cause the glass to crack and hence increase the surface area on the glass. External stresses (for example, those caused by earthquakes) could also increase surface area. In addition, cracks may expose imperfections in waste form (internal gas pockets, nucleation sites, de-vitrification regions) which may cause increased contaminant release rates. Relatively little is known about the long-term behavior of such cracks. Yet the total contaminant release must be known (or at least estimated) for thousands of years. Estimates of cracking and surface area are needed to support performance assessment efforts.

- In Situ Testing of Glass Release: Most testing of waste form performance is done under controlled laboratory conditions that differ from the field conditions actually expected to occur. A field experiment is needed to allow scale-up questions to be explored and enhanced confidence to be generated in the expected performance of the entire disposal system (facility and waste form).

Barrier Technologies for Hanford Closure

An integral consideration in disposal of ILAW is the benefits and/or requirements for permeable or impermeable surface and subsurface barriers. Water is the driving force behind releasing contaminants from waste forms and then carrying those contaminants to groundwater. At Hanford, barrier technology can reduce contaminant migration through limiting moisture flow, or in the case of engineered permeable barriers, even retard specific contaminants through the use of special "sorbents" in the barrier construction. Evaluation of the performance of surface barriers, capillary barriers, and the potential use of sorbents or "getter" materials is needed.

- Surface Barriers: Surface barriers are being used over many Hanford environmental restoration and waste management sites and more barriers are expected in the future. Such barriers are used to reduce moisture infiltration and plant and animal intrusion.

- Short-term testing of barriers has occurred under project-sponsored activities, but long-term studies remain a funding orphan. Project-specific funding at Hanford ends in September 1997. Because the design life of the barrier is 1,000 years, data is needed on barrier degradation to better understand the validity of the design life estimate.

- Capillary Barriers: A sand-gravel capillary barrier consists of a layer of fine material having high conductivity (such as sand) over a layer of coarse material having low conductivity (such as gravel). Unlike a surface barrier (which uses many of the same hydrologic principles), the capillary barrier diverts water away from the object underneath rather than storing the water until evaporation or plant transpiration removes the water. Thus the capillary barrier is expected to have a significantly longer life and be more effective than a surface barrier for moisture diversion. Although the principles of sand-gravel capillary barriers are well established, such barriers (especially the ones the size needed for DOE applications) have not been extensively tested. A large scale sand-gravel capillary barrier needs to be designed, constructed, and operated to obtain performance data to support closure and LLW disposal.

- Getter Materials: To meet the contaminant release specifications for the disposal of Hanford low-activity tank waste, radiocontaminants are physically trapped in glass. However, only a few of these radioelements drive the performance assessment. If these key radioelements could be chemically trapped after their release from glass, then the performance of the waste disposal system could be significantly improved. Hydraulic properties of getter materials (original,

loaded, and discharged) need to be measured to fully understand waste disposal performance in the presence of getters. The use of getter materials in the SRS's disposal of the saltstone waste was an important consideration in the approval of that site's disposal of tank waste.

Path to Solution

- Develop an integrated plan for evaluating disposal site performance criteria, waste form performance, and product quality assurance data and methods to support Hanford Phase I privatization and ORR LLW immobilization decisions.

- Develop waste form standards and test methods, and to adapt and demonstrate industrial methods for product quality assurance to allow DOE to accept waste product from privatization vendors.

Technology ID	PBS #	Technology Name	Stage of Development (FY98)
82	RL-TW06/07	Product Acceptance Testing	Engineering Development
82	RL-TW09	PUF Waste Form Release Test	Advanced Development

FY98-FY00 Scope and Schedule

ILAW Product Acceptance - Work activities to support Hanford's need for ILAW product acceptance will include

- Develop and demonstrate ILAW product acceptance test to support Hanford privatization.
  - Develop detailed plan for acceptance of the privatization vendor provided ILAW product. Compare adequacy and cost of various options for validating product quality (e.g., vendor QA versus independent verification testing) (FY98, TFA & EM-30).
  - Determine the extent of NDE required for product acceptance and draft functions and requirements for an industry solicitation to adapt and demonstrate NDE for vendor-provided product acceptance (FY98, TFA & EM-30).
  - Document acceptance criteria for prediction of long-term glass performance based on expert input. Specify key parameters required for acceptance testing. Provide plan for FY99 efforts to develop and demonstrate the acceptance testing methods (FY98, TFA & EM-30).
  - Demonstrate NDE system and evaluate performance relative to requirements (FY99, TFA & EM-30).
  - Develop and demonstrate acceptance testing method identified in FY98 (FY99, TFA & EM-30). Decision point for implementation.
- Develop and validate reference glass for ILAW.
  - Complete testing and analysis of a nonradioactive standard glasses and three radioactive-doped standard glasses selected in FY97. Recommend standard test method (FY98, TFA & EM-30).
  - Complete round-robin testing of nonradioactive glasses using candidate acceptance test method and reference standard glass (FY98, TFA & EM-30). Decision point for demonstration.
  - Complete full testing, statistical evaluation of replicate tests, and validation of the acceptance test method. Document results and test procedures (FY99, TFA & EM-30).
  - Procure large quantity of standard glasses for use in acceptance testing and as analytical standard for DOE ILAW production efforts at Hanford (FY99, TFA & EM-30). Decision point for implementation.

Performance Assessment of ILAW

- Develop, test, and validate waste form release test to support performance assessment efforts and aid in Privatization Phase II RFP development.
  - Prepare procedures, protocols, and equipment necessary to allow for independent Pressurized Unsaturated Flow through (PUF) testing (FY98, TFA & EM-30).
  - Conduct independent technical review of the Hanford performance strategy to ensure waste acceptance criteria and disposal facility performance assessment constraints are addressed (FY98, TFA & EM-30).
  - Assemble, analyze, and relate the existing international long-term burial data to the Hanford ILAW performance requirements. Evaluate consistency between the performance strategy and existing performance data. Identify issues to still be addressed (FY98, TFA & EM-30).
  - Complete resolution of issues identified in FY98. Validate PUF test method and provide performance data and recommendations to Hanford for use in ILAW disposal performance assessment activities (FY99, TFA & EM-30).
- Estimate waste glass surface area for ILAW to support performance assessments
  - Produce waste forms of the expected variety of sizes, shapes, and fill representing possible Hanford LAW glasses based on privatization vendor input on possible product configurations (FY99, TFA & EM-30).
  - Complete characterization of surface area and crack area of glass samples. Evaluate area reachable by moisture, and determine of unsaturated hydraulic properties of the waste form (FY01, TFA & EM-30). Decision point for demonstration. Transfer of data to support performance assessment efforts.
- Conduct in-situ testing of glass release to support performance assessment efforts
  - Initiate in situ testing using ILAW forms representing the products that will be delivered by the private vendors at Hanford. Develop or adapt existing lysimeters to simulate the entire disposal system (FY99, TFA & EM-30).
  - Conduct lysimeter testing and performance evaluation for at least 5 years to obtain in situ glass release data to substantiate performance assessment predictions (FY03, EM-30).

Barrier Technology - Work activities supporting Hanford's need for barrier technology have and are being performed through efforts within the Subsurface Contaminants Focus Area (SCFA) and EM-40 at Hanford. A full-scale surface barrier prototype has been installed and continued monitoring and performance evaluation are underway. Further efforts to address barrier technology needs, including the capillary barrier and getter materials, will be considered as part of efforts to establish a closure basis, described within problem element 1.3.1.

Other Related Work

- Stability of High-Level Waste Forms (EMSP: FY97, Oak Ridge National Laboratory, $762K)
- Radiation Effects in Nuclear Waste Materials (EMSP: FY96, Pacific Northwest National Laboratory
- Radiation Effects on Materials in the Near-Field of Nuclear Waste Repository (EMSP: FY96, University of New Mexico)
- High Fluence Neutron Source for Nondestructive Characterization of Nuclear Waste (EMSP: FY96, Los Alamos National Laboratory
- Chemical Decomposition of High-Level Nuclear Waste Storage/Disposal Glasses Under Irradiation (EMSP: FY96, Naval Research Laboratory
- Investigation of Microscopic Radiation Damage in Waste Forms Using ODNMR and AEM Techniques (EMSP: FY96, Argonne National Laboratory)

Problem Element Title: 1.3.2 Dispose of LLW

- Determination of Transmutation Effects in Crystalline Waste Forms (EMSP: FY96, Argonne National Laboratory [two tasks])
- Analysis of Surface Leaching Processes in Vitrified High-Level Nuclear Wastes Using In-Situ Raman Imaging and Atomistic Modeling (EMSP: FY96, University of Florida)
- Ion-Exchange Processes and Mechanisms in Glasses (EMSP: FY97, Pacific Northwest National Laboratory, $901K)

Requested Budget

Funding Source	FY98 ($K)	FY99 ($K)	FY00 ($K)
EM-50 TFA	800	2100	1400
EM-50 Crosscut Programs			
EM-50 Industry/University/International			
EM-30/40			
Total	800	2100	1400

Appendix C - Other EM-50 Support

This appendix summarizes other EM-50 support to the TFA. Immediately following are listings of FY97 approved Technology Deployment Initiative (TDI) tasks and Environmental Management Science Program (EMSP) projects that the TFA considers relevant to its own program.

Additionally, the TFA has corresponded with other EM-50 programs to formalize its expected support from each of these programs. Copies of these documents are provided as attachments at the end of this appendix.

- Attachment 1: Characterization, Monitoring, and Sensor Technology Crosscutting Program
- Attachment 2: Efficient Separations and Processing Program
- Attachment 3: Robotics Technology Development Program
- Attachment 4: Industry Programs

Each suggested correspondence summarizes the TFA's understanding of support expected from each program.

C.1 Environmental Management Science Program (EMSP)

The DOE awarded 66 new EMSP research grants in FY97. Following a brief review, twenty-four of them may bear relevance to the TFA program. These are listed below:

- *Chemical Speciation of Inorganic Compounds Under Hydrothermal Conditions* - University of Washington
- *Development of Advanced Electrochemical Emission Spectroscopy for Monitoring Corrosion in Simulated DOE Liquid Waste* - Pennsylvania State University
- *Dynamic Effects of Tank Waste Aging on Radionuclide-Complexant Interactions* - Los Alamos National Laboratory
- *Foaming in Radioactive Waste Treatment and Immobilization Processes* - Illinois Institute of Technology
- *Fundamental Chemistry, Characterization, and Separation of Technetium Complexes in Hanford Waste* - Los Alamos National Laboratory
- *High Temperature Condensed Phase Mass Spectrometric Analysis* - Idaho National Engineering and Environmental Laboratory
- *Ion-Exchange Processes and Mechanisms in Glasses* - Pacific Northwest National Laboratory

- *Mechanics of Bubbles in Sludges and Slurries* - Pacific Northwest National Laboratory
- *Mechanism of Pitting Corrosion Prevention by Nitrite in Carbon Steel Exposed to Dilute Salt Solutions* - Westinghouse Savannah River Company
- *Mineral Surface Processes Responsible for the Decreased Retardation (or Enhanced Mobilization) of ^{137}Cs from HLW Tank Discharges* - Pacific Northwest National Laboratory
- *New Silicotitanate Waste Forms: Development and Characterization* - Pacific Northwest National Laboratory
- *Optically-Based Array Sensors for Selective In Situ Analysis of Tank Waste* - Oak Ridge National Laboratory
- *Particle Generation by Laser Ablation in Support of Chemical Analysis of High Level Mixed Waste from Plutonium Production Operations* - Washington State University
- *Phase Chemistry of Tank Sludge Residual Components* - Sandia National Laboratories
- *Potential-Modulated Intercalation of Alkali Cations into Metal Hexacyanoferrate Coated Electrodes* - University of Washington
- *Radiation Effects on Transport and Bubble Formation in Silicate Glasses* - Argonne National Laboratory
- *Reactivity of Peroxynitrite: Implications for Hanford Waste Management and Remediation* - Brookhaven National Laboratory
- *Removal of Technetium, Carbon Tetrachloride, and Metals from DOE Properties* - Pennsylvania State University
- *Research Program to Investigate the Fundamental Chemistry of Technetium* - Lawrence Berkeley Laboratory
- *Stability of High-Level Waste Forms* - Oak Ridge National Laboratory
- *Synthesis and Characterization of Templated Ion Exchange Resins for the Selective Complexation of Actinide Ions* - Johns Hopkins University Applied Physics Lab
- *The Influence of Radiation and Multivalent Cation Additions on Phase Separation and Crystallization of Glass* - University of Arizona
- *Thermodynamics of the Volatilization of Actinide Metals in the High-Temperature Treatment of Radioactive Wastes* - Lawrence Livermore National Laboratory
- *Thermospray Mass Spectrometry Ionization Processes Fundamental Mechanisms for Speciation and Characterization of Organic Complexants in DOE Wastes* - Oak Ridge National Laboratory

The following TFA-related tasks were approved by DOE in FY96:

- *Acid-Base Behavior in Hydrothermal Processing of Wastes* - University of Texas at Austin
- *Acoustic Probe for Solid-Gas-Liquid Suspensions* - Syracuse University
- *Analysis of Surface Leaching Processes in Vitrified High-Level Nuclear Wastes Using In-Situ Raman Imaging and Atomistic Modeling* - University of Florida
- *Architectural Design Criteria for F-Block Metal Ion Sequestering Agents* - Pacific Northwest National Laboratory

- *Chemical Decomposition of High-Level Nuclear Waste Storage/Disposal Glasses Under Irradiation* - Naval Research Laboratory
- *Chemical Speciation of Strontium, Americium, and Curium in High Level Waste: Predictive Modeling of Phase Partitioning During Tank Processing* - Pacific Northwest National Laboratory
- *Collodial Agglomerates in Tank Sludge: Impact on Waste Processing* - Pacific Northwest National Laboratory
- *Design and Development of a New Hybrid Spectroelectrochemical Sensor* - University of Cincinnati
- *Design and Synthesis of the Next Generation of Crown Ethers for Waste Separations: An Inter-Laboratory Comprehensive Proposal* - Oak Ridge National Laboratory
- *Determination of Transmutation Effects in Crystalline Waste Forms* - Argonne National Laboratory (two tasks)
- *Enhanced Sludge Processing of HLW: Hydrothermal Oxidation of Chromium, Technetium, and Complexants by Nitrate* - Los Alamos National Laboratory
- *f-Element Ion Chelation in Highly Basic Media* - University of New Mexico
- *High Fluence Neutron Source for Nondestructive Characterization of Nuclear Waste* - Los Alamos National Laboratory
- *Imaging and Characterizing the Waste Materials Inside an Underground Storage Tank Using Seismic Normal Modes* - Massachusetts Institute of Technology
- *Interfacial Radiolysis Effects in Tank Waste Speciation* - Pacific Northwest National Laboratory
- *Investigation of Microscopic Radiation Damage in Waste Forms Using ODNMR and AEM Techniques* - Argonne National Laboratory
- *Microstructural Properties of High Level Waste Concentrates and Gels with Raman and Infrared Spectroscopies* - Los Alamos National Laboratory
- *Mixing Processes in High-Level Waste Tanks* - University of California at Berkeley
- *New Anion-Exchange Resins for Improved Separations of Nuclear Materials* - Los Alamos National Laboratory
- *On-Line Slurry Viscosity and Concentration Measurement as a Real-Time Waste Stream Characterization Tool* - University of California at Davis
- *Polyoxometalates for Radioactive Waste Treatment* - Georgetown University
- *Processing of High Level Waste: Spectroscopic Characterization of Redox Reactions in Supercritical Water* - Furman University
- *Radiation Effects in Nuclear Waste Materials* - Pacific Northwest National Laboratory
- *Radiation Effects on Materials in the Near-Field of Nuclear Waste Repository* - University of New Mexico
- *Studies Related to Chemical Mechanisms of Gas Formation in Hanford High-Level Nuclear Wastes* - Georgia Institute of Technology
- *Superconducting Open-Gradient Magnetic Separation for the Pretreatment of Radioactive or Mixed Wate Vitrification Feeds* - Argonne National Laboratory
- *The NOx System in Nuclear Waste* - Argonne National Laboratory

C.2 Technology Deployment Initiatives (TDI)

Nineteen TDI proposals were selected for FY97 funding. Six proposals relate to the TFA.

- *Washable Metal HEPA Filters* - Idaho Operations Office
- *Electrochemical Ion Exchange for Contaminant Removal and Waste Reduction* - Oak Ridge Operations Office
- *Modular Evaporator System for Waste Volume Reduction in Tanks* - Oak Ridge Operations Office
- *Improved Systems for Tank Sludge Retrieval, Conditioning, and Transfer* - Oak Ridge Operations Office
- *Slurry Monitoring* - Richland Operations Office
- *AEA Fluidic Sampler* - Savannah River Operations Office

RL-F-1325.6# DEF012
(04/93)

United States Government **Department of Energy**

memorandum

Richland Operations Office

DATE: JUN 06 1997
REPLY TO
ATTN OF: STP:LSM/97-STP-416

SUBJECT: CHARACTERIZATION, MONITORING AND SENSOR TECHNOLOGY (CMST) CROSS-CUT PROGRAMS (CP) SUPPORT TO THE TANKS FOCUS AREA (TFA)

TO: Caroline B. Purdy, Program Manager
Characterization, Monitoring,
and Sensor Technology, EM-53, HQ

TFA looks forward to continued collaboration with CMST. The TFA has been in close contact with your team on the collaborations for fiscal year (FY) 1998. This letter formalizes TFA support for CMST funding of the following tasks.

1. Hanford Tanks Initiative (HTI) Vadose Zone CP Sensor Package and Soil Sampler

   As you are aware, the characterization function of the HTI is to deploy technologies to estimate the inventory of chemical and radionuclides constituents of concern (CoC) left in Tank 241-AX-104 and that may have leaked into the surrounding backfill and soil column. Information gained will support the performance assessment modeling for the AX tank farm and development of retrieval and closure alternatives for the Hanford Site single-shell tanks. As a part of the effort to map the location, extent of migration, and concentration of CoCs that exist in the backfill and surrounding vadose zone, state-of-the-art sensors will be deployed using the Hanford cone penetrometer platform and applying industry standard cone penetrometer techniques. An abbreviated program plan is attached that provides more detail on the scope of this initiative.

   There is a schedule urgency and funding constraint anticipated in FY 1998 to fully implement the program as planned. Funding support for fielding activities at Hanford has been requested from the Tanks Waste Remediation System (TWRS) Vadose Zone Characterization Program. In addition, this letter solicits your support through the CMST-CP to support completion of the engineering, system validation, and cold testing at Waterwaste Experimental Station (WES) and the Hanford Site in FY 1998. Available Hanford program resources would be focused on field

ATTACHMENT 1

engineering tasks (i.e., safety, readiness assessment, technical and operations interface, procedures, sampling and analysis planning etc.) and hot deployment as the tools become available in late FY 1998. The attached plan also briefly delineates tasks that are expected to be completed in FY 1997, and identifies FY 1998 work scope and estimated funding requirements (highlighted) proposed to be sponsored by CMST-CP, which would total $600K.

Application of these technologies at the Hanford tank farms will represent a significant contribution toward the required tank waste remediation decisions. We plan for both the TWRS Vadose Zone Characterization (EM-30) and Environmental Restoration (EM-40) Programs at Hanford to use these and other cone penetrometer deployed sensors as alternative technologies to complement baseline methods as a part of the Hanford integrated soil and groundwater characterization strategy.

To summarize, the TFA supports the funding by CMST totalling $600K, in FY 1998 to execute all or part of two of the eight tasks in the "HTI Plume Characterization Sub-task."

2. Slurry Monitoring:

   a. It is our understanding that the task "Comparative Testing Pipeline Slurry Monitors," at Oak Ridge National Laboratory (ORNL) will be funded at $350K with the objective to deploy and validate the use of slurry transport monitors selected from the FY 1997 comparative test conducted on the Slurry Test Loop. The TFA supports this funding.

   b. If any of the slurry monitors, currently being developed by CMST (at Argon National Laboratory (ANL), Sandia National Laboratories, and Pacific Northwest National Laboratory (PNNL), are judged worthy of further development (based on the results in the FY 1997 ORNL Comparative Tests), continued funding would be provided.

3 Breakthrough Column Monitors:

   a. For the PNNL task "Process Monitor for Cs-137 Column Breakthrough," a decision was made at the CMST Mid-Year to fund it through FY 1998. We understand this will be funded at $250K in FY 1998. The TFA supports this funding.

   b. For the ANL task "Process Monitors for Tc-99 Column Breakthrough." Phil McGinnis and Tom Thomas recommended at the CMST mid-year that the performance indicator should demonstrate proof-of-principle for detection of non-pertechnetate species in FY 1997 as a prerequisite to FY 1998 funding. We understand this will be funded at $300K in FY 1998. The TFA supports this funding.

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4. High Level Waste Sludge Washing Monitors:

   During the FY 1996 call for proposals and selection process, the CMST review group decided to postpone selection of a principal investigator, requested that TFA write a better set of specifications, and recommended that the call be re-issued in FY 1997. The recommended funding level in the FY 1996 call was $350K. Paul Wang has requested that the TFA consider the possibility of combining the CMST task into the FY 1998 TFA call for proposals (as a collaborative laboratory call).

5. Nitrate/Nitrite/Hydroxide Monitor:

   The CMST and TFA are sharing the cost of phase one ($87.724K) of this joint industry project to develop a nitrate/nitrite/hydroxide monitor; the Savannah River Site is interested in this technology for use in monitoring corrosion inhibitor concentrations in high level waste tanks. We understand that CMST expects to fund all of phase two of the project at a funding level of $197K. The TFA supports CMST funding of this project.

In summary, the TFA supports CMST is funding of the above tasks in FY 1998 totaling $1850K. We appreciate the support of the CMST and look forward to another very productive year. If you have any questions, please contact me on (509) 372-4546 or Billie Mauss, Program Development Manager on (509) 372-4512.

Jeffrey A. Frey, Program Manager
Tanks Focus Area

Attachment
Abbreviated Program Plan for
CP Deployment HTI

ATCH 1

Abbreviated Program Plan for CP Deployment at Hanford Tank Farms

Background

The Hanford Tanks Initiative (HTI) is an ongoing, four-year project resulting from the technical and financial partnership of the U. S. Department of Energy (DOE) Office of Waste Management (Environmental Management [EM]-30) and the Office of Science and Technology (EM-50). One of the objectives of the HTI project is to characterize the extent of vadose zone contamination beneath specified Hanford Site tank farms. This aspect of the HTI effort has been identified as contaminant plume technology development and demonstration with the initial demonstration taking place in the 200 East Area 241-AX Tank Farm. The overall plume characterization task will be accomplished by a coordinated team consisting of staff from HTI, the U.S. Army Corps of Engineers/Waterways Experiment Station (WES), Pacific Northwest National Laboratories (PNNL), and Applied Research Associates, Inc. (ARA). The plume characterization effort is planned to take place within a three-year period (fiscal years 1997 through 1999).

The overall goal of the contaminant plume technology development task is to demonstrate mapping of the location, extent, and contaminant concentration gradient of a single shell tank (SST) leakage-derived plume. This task will initially focus on the backfilled soils and vadose zone surrounding tank AX-104 in the 241-AX tank farm on the DOE Hanford Site. The soils are to be interrogated for traceable contaminants of concern (COCs) including metals and gamma emitting radionuclides. Specific plume characterization technology and deployment goals of this effort include the following:

- Obtain soil and data samples for analytical speciation of the AX-104 tank [waste] contaminant plume and vadose zone
- Obtain multiple soil samples from selected horizons during a single, CP probe deployment event
- Detect and avoid sub-surface metal objects during CP probe deployment
- Develop and deploy reusable multisensor and soil sampling probes
- Demonstrate the capability to seal CP holes following deployment

Note that the terms Adevelopment@, and Adesign@, as used in this discussion, refer to the task of engineering and using existing technology components in unique, new ways. Fabrication of new tools that combine existing instruments, sensors, and components requires designing appropriate instrument housings, configurations, and interfaces. During the technology Adevelopment@ process, these existing and enhanced tools will be modified and reconfigured, allowing them to operate under conditions beyond those encountered as single purpose tools.

The need for this technology/capability lies in the mission of vadose zone interrogation and monitoring around underground waste storage tanks (i.e., single-shell tanks - SSTs).

ATCH 1

Determining the quantity and extent of waste movement through the vadose zone and backfill soils surrounding SSTs is a primary component of decision-making regarding tank farm closure. The determination of vadose zone plume content and extent, together with questions regarding practical limits of waste retrieval, and the technical defensibility of characterization data, pose significant technological challenges. SST vadose zone monitoring and characterization tools, when deployed, will contribute vital information for both storage and custodial monitoring functions, and planned retrieval operations by providing potential leakage confirmation and assessment.

Technology Description

The existing baseline deployment methods and plume characterization tools consist of metal pipes (referred to as drywells, or boreholes) that are drilled or driven into the backfill soil and vadose zone surrounding individual tanks and tank farms. Drilling is used to advance larger (6-10 inch dia.) pipe. This technique incurs significant ALARA risks, increased cost, and soil/waste disposal challenges due to the drill cuttings that are produced. Smaller diameter (2-4 inch dia.) pipe can also be drill-advanced, but can also be driven (i.e., hammered) or pushed into place. This method is referred to as the cone penetrometer technique (CPT). Using CPT, smaller, pushed or driven pipe installations have been made in tank farm soils to supplement the larger pipe/borehole installations. These boreholes (typically 4 in. or less in diameter) are closed-tip pipe strings that can be driven to depths of hundreds of feet. The CPT deployment is significantly less expensive and is not hindered by the ALARA and waste remediation concerns of working with drilling cuttings. However, the use of these boreholes is also limited, like the larger boreholes, to baseline, passive, plume interrogation techniques: there is no opportunity to take soil samples during deployment, and there are similar safety concerns regarding detecting and avoiding subsurface piping and metal objects.

The boreholes provide instrument access to the soil. The large diameter boreholes, already in position around most tanks, are used to periodically monitor the vertical distribution of gamma emitting radionuclides and soil moisture content. If a contaminant plume moves in a path that intercepts the drywell location, and is within the range of interrogation for borehole-deployed instruments (typically a radius of 6-10 inches), data can be obtained. These data serve to identify the plume presence, the extent of the plume (depth and vertical size), whether certain contaminants are present, and to some degree, the quantities of those contaminants relative to the plume size. Confidence in the plume identification and monitoring data are influenced by the number of boreholes from which data are taken and the spacing between boreholes. Even at those tanks surrounded by several boreholes, the spacing between boreholes is typically 20-30 feet, leaving most of the soil mass uninterrogated. Therefore plume size, extent, and shape is typically estimated by interpolation and extrapolation of data from adjacent boreholes, and by factoring in hydrogeology and soil characterization factors. In addition, boreholes are commonly extended to different depths. Current neutron and gamma probes provide data from these boreholes. These Aborehole logging@ activities are conducted on an infrequent or periodic schedule as needed. Actual soil grab samples are not available from these installations, unless they are/were taken during initial borehole emplacement. Safety issues are appropriately raised whenever this type of deployment, or drill-emplacement is suggested in close proximity to the storage tanks. Drilling baseline type boreholes, in numbers that would significantly improve surveillance and data confidence, is cost prohibitive ($500K to $1M each).

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The planned work under the HTI plume characterization effort targets the technology gap between available soil sensor and sampling instruments, and their deployment into optimum plume characterization positions. The work also addresses the need to safely deploy minimally intrusive sensors and sampling tools to more accurately define the extent of contamination and quantify the inventory of COCs. The approach to this effort is to take the positive, useful aspects of the current baseline (for both deployment and down-hole instrumentation) and enhance them. This will provide a cost efficient, safer, faster, easier, precise deployment approach to more completely interrogate the vadose zone. The analytical tools and deployment techniques to be provided will modify and enhance existing commercial CP technologies and methods, and improve upon the current plume characterization capabilities. The planned deployment approach, and advanced sensors, will provide a basis for designing and deploying future vadose zone surveillance instruments. This system can be used for a wide variety of environmental applications not restricted to tank farms. Upon proof of this approach, the tools will be applied to significantly more rigorous environments, notably the SX tank farm, quickly followed by the TX farm. These tools will likely be deployed across the Hanford Site through the Environmental Restoration Program=s RCRA monitoring and Assessment activity.

An available, commercially provided, and widely used, cone penetrometer (CP) piping string will be used to deploy a new generation of soil sensor and soil sampling probes. Small diameter (i.e., 2 inch or less) CP piping strings, with integrated instrument and sampling probes, will be deployed into the backfill soils and underlying sediments near a SST. The probes will be advanced according to a carefully designed deployment and sampling strategy to obtain useful, appropriate, and defensible data about plume content and extent. The target depths for deployment of the probes ranges from 50 to 150 feet below surface. The probes will provide data for an expanded suite of constituents, and that information will be combined with historic data to support waste retrieval and tank/tank farm closure decisions. CP pipe units installed by this project may be left in place to provide added capability for vadose zone surveillance efforts that could pave the way to formation of a virtual sensor Abarrier@ around SSTs.

Two types of CP probes will be used during the planned task: a multi-sensor probe (containing a gamma radiation detector and x-ray fluorescence (XRF) detector; and a soil sampling probe. These two probes will be deployed during separate CP push events in close proximity to each other (within 1-2 feet). The probes are deployed by attaching them into the overall CP piping string. The pipe containing the sensor probe package will be placed in the first CP pipe position so that data may be collected from the maximum depth. Likewise the soil sampling probe will be at the tip of the CP string to obtain soil samples from the Afront@ of the push.

A gamma spectrometer will provide conventional gamma logging. The XRF sensor will be used to detect the presence of uranium (i.e., U-238), which is one of the highly mobile plume constituents, along with I-129 (Iodine), Np-237 (Neptunium), Se-79 (Selenium), and Tc-99 (Technetium). The soil sampling probe will be used to obtain discrete (multiple) soil samples at specified/desired depths in areas where contaminants are suspected or have been found. These samples will be assayed at the field location, then packaged and submitted for on-site (Hanford) laboratory analysis. Soil sample retrieval will be through the pipe string. Soil samples are planned to be taken in close proximity to the location where the initial sensor probe indicated contamination (i.e., plume presence).

Schedule and Planning

ATCH 1

The plume characterization effort consists of three major elements: technology preparation, field deployment, and data/sample analysis and reporting. The goals and requirements of the three elements will be met through the activities planned within seven tasks. An eighth task will apply these data to the process of risk assessment for waste retrieval/closure in the AX tank farm. The following table (*HTI Plume Characterization Sub-task*) summarizes the schedule for these tasks:

HTI Plume Characterization Sub-task	
Task Title	**Schedule**
1. Phase I CP probe tech prep	5/97 |----------| 10/97
2. Phase II CP probe tech prep	10/97 |----------| 3/98
3. Hanford CP Fielding Plan-I	4/97 |----------| 10/97
4. Hanford CP Fielding Plan-II	10/97 |----------| 6/98
5. Hanford Cold Test Deployment	1/98 |----------| 6/98
6. Hanford Hot Deployment	4/98 |----------| 9/98
7. Data/Sample Analytical Work	7/98 |----------| 9/99
8. AX-104 Risk Assessment	6/98 |----------| 11/98

The cone penetrometer (CP) soil sensor and sampling probes will be prepared during the technology preparation task. This activity will include re-engineering and Apackaging@ of existing CP tools into a configuration that can be deployed at Hanford using commercial CP resources and the Hanford CP platform. The technology preparation element includes probe fabrication, testing, calibration, and cold tests. These activities are planned to complete in two phases spanning two fiscal years: Phase I during the last half of FY-97 and Phase II during the first half of FY-98. Phase I is the initial engineering and development of the probes and Phase II covers the probe fabrication and calibration tasks and includes final acceptance testing and a deep push, full operational cold test deployment of the probes at the vendor=s location. A cold test, Abridging@ activity/deployment is planned at the Hanford Site during the second and third quarters of FY-98. This activity will involve a cooperative deployment (between the developer (vendor) and the user (Hanford Site)) prior to Ahot@ deployment around SST AX-104. The hot deployment, or Afielding@, is planned for the third and fourth quarters of FY-98. Sample and data analysis will be carried out during the last quarter of FY-98 through the second quarter of FY-99.

The following sections summarize the activities within each of the seven major Plume Characterization Sub-task work elements. Current funding for each task is listed, planned budget/funding is also stated, plus a rough-order-of-magnitude (ROM) cost estimate (+/- 15%) is given that represents the best planning estimate of needed funding to accomplish the task as currently scoped. This information is summarized in the table following the discussion sections, A*Summary of Proposed ROM Estimate of Needed Funding and Sponsor Programs*@.

ATCH 1

Task 1: Phase I CP Probe Technology Preparation

This work provides the CP probe technology Apackage@ ready for deployment into the Hanford 241-AX tank farm. Phase I work produces the probe engineering/configuration and initial testing calibration of the sensor components. The soil samplers will also be fabricated and tested for function. Performers: WES/ARA

Fabricate housing for multisensor (MS) probe

C. Fabricate multisensor XRF and spectral gamma instruments
C. Fabricate multi-sample soil sampling probes (2)
C. Bench test and begin calibration of MS probe instruments
C. Initial shallow push tests of MS and multi-sample probes
C. Complete all Phase I documentation/reports
C. Complete acceptance tests for Phase I work/hardware

FY-97 funding support is through HTI for $550K.

Task 2: Phase II CP probe Technology Preparation

This work provides the CP probe technology Apackage@ ready for deployment into the Hanford 241-AX tank farm. Phase II work completes fabrication, testing, and calibration of the sensor probe and the sampler probe. A cold test of the CP probes will be conducted at the vendor=s location. All acceptance tests will be concluded during this phase and the probes will be transferred to the Hanford/HTI Acustomer@. Performers: WES/ARA

Procure, test, configure data acquisition and processing equipment

C. Complete multisensor probe calibration study

Complete laboratory study to establish XRF detection limits for metals

C. Complete fabrication of second (backup) MS probe assembly
C. Bench test second MS probe assembly
C. Complete calibration of both multisensor probe instruments
C. Conduct full depth (50-150ft) [cold] field demonstration at WES
C. Complete all acceptance testing and Phase II documentation
C. Transfer completed probes and operating procedures to Hanford/HTI

ROM estimates for total needed funding are $450K.

Task 3: Hanford CP Fielding Plan - Phase 1

This work provides the first revision of the Hanford deployment documentation (i.e., Fielding Plan) needed to get into 241-AX: Fielding Plan. All required basis, reference, permitting, safety, QA, Health Protection, etc., and related approvals will be compiled within this document. Performers: Hanford resources.

C. Complete initial (Rev. 0) of the CP probe Fielding Plan

FY-97 funding is through HTI for $63K.

ATCH 1

Task 4: Hanford CP Fielding Plan - Phase II

This work provides the final revision (Rev. 1) of the Hanford CP Fielding Plan. The major portion of the Fielding Plan details will be completed during this revision and information will be incorporated from the vendor and Hanford cold testing activities. The Hanford Vadose Zone Characterization program (VZC) benefits from this activity because the approvals and documentation that are completed can be applied to VZC tasks with minor modification/updating. Performers: Hanford resources.

- C. Complete Rev. 1 of the CP probe Fielding Plan
- C. Obtain all required approvals/signoffs for CP fielding event(s) FY-98

ROM estimates for total needed funding are $130K.

Task 5: Hanford Cold Test Deployment

This work provides for the completion of technology transfer from WES to Hanford, final checkout and closure on technology issues, revision and completion on Fielding Plan items, and training for actual tank farm deployment. The activities of the technology phase overlap/merge with the deployment activities under this work element. Performers: WES/ARA/Hanford forces

- C. Complete WES system configuration to Hanford CP platform
- C. Complete WES MS probe and sampler validation tests at Hanford
- C. Conduct cold test deployment of CP probes (sampler and MS) at Hanford
- C. Complete WES training of contract personnel

ROM estimates for total needed funding are $330K.

Task 6: Hanford Hot Deployment of CP Probes Around Tank 241-AX-104

This work represents the actual deployment action for the CP-probes around SST AX-104. The HTI fulfills technology deployment goals during this effort, and the Hanford Vadose Zone Characterization (VZC) effort obtains a proven, viable deployment tool to use with other VZC missions. Performers: Hanford resources.

- C. Conduct hot deployment of CP probes at Hanford 241-AX-104 tank

ROM estimates for total needed funding are $400K.

Task 7: CP Sensor Data and Soil Sample Analytical Work-up

This work element provides for processing of the CP sensor data and analytical workup of the soil samples. The results will be compiled into a formal report. Data from the field and from the laboratory will be correlated. Results from the analytical work will be provided to support the HTI Retrieval Performance Evaluation Report and to the VZC program. Performers: Hanford forces

ROM estimates for total needed funding are $320K.

Task 8: AX-104 Risk Assessment (by others)

ATCH 1

A Retrieval Performance Evaluation Criteria Assessment (RPECA) for AX tank farm will be developed. Waste sources that potentially contribute to short-term and long-term risk, and that will be considered in evaluating and comparing retrieval/closure alternatives, will be addressed. The task includes Hanford stakeholder involvement activities, compilation of engineering data, short-term risk assessment for accidents and routine exposures, contaminant transport modeling for long term risk assessment, regulatory compliance assessment, and evaluation and comparison of alternatives relative to performance measures. Real-time, qualitative data from the CP plume characterization subtask will be provided to support this task, assessed, and incorporated into the final draft of the RPECA conclusions and recommendations report.

ATCH 1

Summary of Proposed ROM Estimate of Needed Funding and Sponsor Programs		
Task	**ROM Est. Funding**	**Recommended Funding Split**
1	N/A	N/A (Current year funding under HTI)
2	$450K	**$450K/CMST-CP**
3	N/A	N/A (Current year funding under HTI)
4	$130K	Hanford Programs (HTI, VZCP)
5	$330K	**$150K/CMST-CP**, $180K/HTI
6	$400K	Hanford Programs (HTI, VZCP)
7	$320K	Hanford Programs (HTI, VZCP)
8	N/A	N/A (Funding by others: not plume characterization task)

ATCH 1

RL-F-1325.6# DEF012
(04/93)

United States Government **Department of Energy**

memorandum

Richland Operations Office

DATE: JUN 16 1997
REPLY TO ATTN OF: STP:BMM/97-STP-432

SUBJECT: EFFICIENT SEPARATIONS PROGRAM (ESP) SUPPORT TO THE TANKS FOCUS AREA (TFA)

TO: Satyendra P. Mathur
Office of Technology Integration
EM-54, HQ

TFA looks forward to continued collaboration with ESP. TFA knows the technical team has been in close contact with your team on the collaborations for Fiscal Year (FY) 1998. This letter formalizes the support of TFA for ESP funding of the following tasks. The funding amounts listed are TFA's understanding of the ESP commitment in FY 1998 and are levels supported by the TFA.

1. Technetium in Hanford Tanks ($300K)

   AL17C321- Characterization and separation of non-pertechnetate species in Hanford wastes (Norm Schroeder, Los Alamos National Laboraotry $300K

   Non-pertechnetate species in Hanford tank waste is still considered an important issue by TFA and supports Hanford's need #533 from the FY 1996 Needs Assessment. Although Hanford chose not to resubmit this need for FY 1998, the work ESP initiated in FY 1997 should be completed to help address an important issue impacting Hanford privatization. We understand the scope will include: (a) determination of non-pertechnetate species; (b) understanding the relative effectiveness of different oxidation processes; (c) discussions with site personnel about the effect of oxidation products on the total site flowsheet; (d) determination of destruction or separation goals for Hanford.

2. Solvent Extraction for Idaho National Engineering and Enviromental Laboratory (INEEL) Sodium Bearing Waste ($855K)

   CH26C321 - Advanced Integrated Solvent Extraction System (Phil Horwitz, Argon National Laboratory) $100K

   OR16C341 - Integrated Solvent Extraction - Tc, Cs, Sr (Bruce Moyer, Oak Ridge National Laboratory [ORNL]) $350K

   RL36C331 - Ligand Modeling and Design (Ben Hay, Pacific Northwest National Laboratory [PNNL]) $80K

   The TFA supports funding the above three Technical Task Plans (TTPs) as a group of related activities that support INEEL's need #645. We understand the primary goal of: (a) Horwitz's work is to ready a flow

ATTACHMENT 2

sheet for testing at INEEL; (b) Moyer's work is to demonstrate on a laboratory scale a solvent extraction flowsheet for removal of Cs for INEEL: Hay's work is to support Horwitz and Moyer.

Khlopin Radium Institute - Cobalt Dicarbollide Extractant
(Russia; contact: Jack Watson, ORNL) $75K

The performance of this technology is promising; the TFA anticipates demonstrating this at INEEL using sodium bearing waste in support of Need #645. We understand the FY 1998 work scope will include testing as necessary to establish this as a viable process for Cs/Sr separations at INEEL. We also understand that the FY 1998 funding allocation actually covers the second half of the fiscal year; i.e., this work actually is proceeding at a rate of $150K/year.

ID76C311 - Bench scale Testing for Separation of INEEL Waste
(Terry Todd, INEEL) $250K

TFA strongly supports funding this task to enable and integrate: (a) the above ESP work involving sodium bearing waste at INEEL; (b) leveraging with Vadose Zone Characterization (Waste Management), and Science and Technology Development, TFA funding at INEEL.

3. Ion exchange materials for INEEL sodium bearing waste ($250K)

Technical University, Prague - Polyacrylonitrile engineered forms
(Czech Republic; contact: Jack Watson, ORNL) $50K

This technology has performed well as an engineered form for ammonium molybdophosphate (AMP) in recent cesium removal tests at INEEL. This serves as a promising organic backup to potential inorganic forms of AMP for sodium bearing wastes at INEEL and supports Need #645. We understand this task will support additional testing as necessary to establish this as a suitable engineered form at INEEL. We also understand that the FY 1998 funding allocation actually covers the second half of the fiscal year; i.e., this work actually is proceeding at a rate of $100K/year.

OR16C342 - Patent documentation and AMP engineered form
(Jack Collins, ORNL) $200K

ORNL's microsphere technology is a promising inorganic engineered support for AMP for sodium bearing waste at INEEL. We understand that the FY 1998 scope will include demonstration of the microsphere form for AMP using simulated INEEL waste.

4. Process chemistry ($690K)

SR16C342 Advanced Chemical Separations at SRS
(Major Thompson, Savannah River Technology Center [SRTC]) $250K

This task covers a suite activities at Savannah River Site (SRS) important to the TFA and supports SRS Needs #618 and #619. The TFA

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supports increased participation by Major Thompson in directing work in this task.

RL36C341 Salt Splitting Using Ceramic Membranes
(Dean Kurath, PNNL) $300K

This task, combined with support of Dave Hobbs at SRTC through SR16342 and with consideration of the possible continuation of the ESP's former "clean salt" work (Dan Herting, Numatec Hanford), are an important suite of activities pertaining to recycle of caustic at Hanford and related topics, such as salt splitting and sodium decontamination. This work supports SRS and Hanford Needs #637 and #668, respectively.

RL46C342 Liaison with Institute of Physical Chemistry, Moscow
(Cal Delegard, PNNL) $100K

Institute of Physical Chemistry, Moscow
(Russia; contact: Jack Watson, ORNL) $40K

The TFA does not consider the above two TTPs to be high priority tasks but recognizes that, in combination, information useful to Hanford and SRS is being made available at minimal cost. We understand the FY 1998 scope will include: working more closely with the Russians to ensure that complex solutions are used that resemble alkaline wastes in the United States; taking an active role in relating the importance of the Russian work to the appropriate Environmental Management users; insuring that the more important of the information acquired is submitted to well-known peer-reviewed western journals.

We also understand that the FY 1998 funding allocation for the Russian work actually covers the second half of the fiscal year; i.e., this work actually is proceeding at a rate of $80K/year.

In summary, the TFA supports ESP funding of the above tasks in FY 1998 totaling $2095K. We appreciate the support of the ESP and look forward to another very productive year. If you have any questions, please contact me on (509) 372-4546 or Billie Mauss, Program Development Manager on (509) 372-4512.

Jeffrey A. Frey, Program Manager
Tanks Focus Area

ATCH 2

RL-F-1325.6# DEF012
(04/93)

United States Government **Department of Energy**

memorandum

Richland Operations Office

DATE: JUL 10 1997
REPLY TO ATTN OF: STP:LSM/97-STP-463

SUBJECT: ROBOTICS TECHNOLOGY DEVELOPMENT PROGRAM (RTDP) SUPPORT TO THE TANKS FOCUS AREA (TFA)

TO: Linton W. Yarbrough
Albuquerque Operations Office

TFA looks forward to continued collaboration with the RTDP. TFA knows the technical team has been in close contact with your team on the collaborations for fiscal year (FY) 1998. This letter formalizes the support of TFA for RTDP funding of the following tasks. The funding amounts listed are TFA's understanding of the RTDP commitment in FY 1998 and are levels supported by the TFA.

1. Arm-Based Tank Waste Retrieval ($900K)

   a. TARZAN ($250K)

      The TFA understands the RTDP will assist West Valley with implementation of the multi-link hydraulic manipulator system called TARZAN. We understand Oak Ridge National Laboratory (ORNL) and Sandia National Laboratories (SNL) will evaluate design concepts and participate in design reviews, acceptance testing, installation, deployment, the Florida International University, SNL and ORNL will perform dynamic analyses, perform simulations, and evaluate and develop control strategies, including inverse kinematic control and force reflection.

   b. Automated analysis of tank samples ($250K)

      The TFA has requested that RTDP collaborate on an automated mixing tank sampling and analysis system (need #674) for on-line analysis of radiological properties, chemical properties, and physical properties such as particle size and solids content of wastes before they are transferred to processing cells. We understand that a system for deployment at Hanford will be developed over three years.

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c. Design for Remote Maintenance ($400K)

The TFA has requested assistance from the RTDP with design for remote maintenance of compact processing units, specifically the ORNL Waste Conditioning Compact Processing Unit (CPU). The TFA is funding development of the ORNL CPU in support of need #610 and so design support for the remote maintenance system also is support for the TFA's need #610. We understand the RTDP will provide design guidance to facilitate remote maintenance of the CPU. We understand the task could be expanded to include common design problems that will be faced by compact processing units at Savannah River Site.

2. Vehicle-Based Tank Waste Retrieval ($1700K)

a. Houdini-II ($1000K)

The TFA supports completion of Houdini II. We understand RedZone is funded to complete the design in FY 1997 ($1M at Fernald), and that RTDP will fund the fabrication, testing and deployment in the ORNL Gunite And Associated Tanks in FY 1998.

b. Old Hydrofracture Facility (OHF) Heel Removal ($700K)

The TFA will be providing a bore hole miner extendible nozzle for dislodging sludge from tanks in support of the Office for Environmental Restoration (EM-40), OHF Remediation Project (need #606). The TFA supports collaboration by the RTDP with EM-40 to develop a vehicle system to position a jet pump for removing the sludge heel from and to deploy characterization sensors in the OHF tanks. We understand the vehicle will be off-the-shelf and deployable through the two foot diameter risers installed in FY 1997 at the OHF tanks.

In summary, the TFA supports RTDP funding of the above tasks in FY 1998 totaling $2600K. We appreciate the support of the RTDP and look forward to another very productive year. If you have any questions, please contact me on (509) 372-4546 or Lance Mamiya, Project Execution Manager, TFA on 372-4033.

Billie M. Mauss for

Jeffrey A. Frey, Program Manager
Tanks Focus Area

ATCH 3

RL-F-1325.6# DEF012
(04/93)

United States Government **Department of Energy**

memorandum

Richland Operations Office

DATE: AUG 28 1997
REPLY TO ATTN OF: STP:LSM/97-STP-589

SUBJECT: INDUSTRY PROGRAMS FISCAL YEAR (FY) 1998 SUPPORT TO TANKS FOCUS AREA (TFA)

TO: William F. Haslebacher
Federal Energy Technology Center

TFA looks forward to continued collaboration with the Federal Energy Technology Center (FETC). Your visit to Hanford and the collaboration that the technical team has had with you and your office will ensure that we are both prepared for the FY 1998 projects. This letter formalizes the TFA support for FETC funding and documents our discussion of the technical projects of interest to TFA.

Itemized below in order of priority are the TFA industrial needs, which were discussed with you during your visit to Hanford:

- Waste Form Product Acceptance Testing (TFA Need #675)

  The initial phase of this task was to be a proof of technical capabilities for integrating commercially available technologies, which are used on smaller waste packages. The outcome was to be a larger, integrated, non-destructive (NDE) system for evaluation of final waste form packages. The TFA estimated FY 1998 funding requirements of $100-200K, with an increase to $800K in FY 1999. The TFA reviewed this scope of work with Hanford Tank Waste Remediation System users, and determined that a Non Destructive End Effector (NDE) system for product acceptance will not be required. Therefore, TFA requests this activity be eliminated.

- Out of Tank Evaporator (TFA Need #632)

  In FY 1998, TFA will determine whether this technology will be suitable for treatment of the waste stream at Savannah River Site (SRS). If as anticipated, the technology meets the required specifications, TFA will provide detailed specifications to FETC. This specification package should be delivered to FETC by February 1998. We request that FETC award a contract and the vendor supply initial design drawings for approval by the TFA within 3 months of award of contract, with the cold testing unit by December 1998. This will allow cold testing to be completed in FY 1999 and hot deployment

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in FY 2000. Estimated cost of the procurement will be $525K in FY 1998 and on the order of $1M in FY 1999. The total cost of this procurement may be higher; a better cost estimate will be developed as specification details are obtained. The Office of Waste Management (EM-30), TFA, and FETC are expected to jointly fund this work.

- Metal Filters for Waste Tank Ventilation (TFA Need #629)

  The TFA will develop the technical specifications for this Request for Proposals (RFP) and deliver it to FETC by early calendar year 1998. FETC will initiate sintered metal filter and system design call for industrial support in FY 1998. It is recommended that the industry design concepts be obtained by the start of FY 1999 for down-selection and initiation of final design and fabrication. The TFA estimated FY 1998 funding requirement is $500K.

- Defence Waste Processing Facility (DWPF) Level and Density Monitors (TFA Need #636)

  TFA recommends that the ongoing FETC project continue with SEA, delivering the current system to Hanford for testing. In addition, SRS has made an FY 1998 Technical Task Plan (TTP) commitment to test the current SEA system for measurement of liquid/organic interfaces in DWPF process vessels. Therefore, the TFA would like the Science and Engineering Associates (SEA) scope expanded, as needed, to allow for SRS testing in conjunction with TFA and EM-30 program activities. This may not result in any additional costs to the FETC contract.

  The TFA would also like FETC to consider revisiting the original SEA proposal, and extending the contract to further develop the acoustic based system. The acoustic based system has potential application at SRS for measuring the glass frit/water interface in hold tanks for DWPF recycled glass frit and monitoring the settling rate of solids in waste tanks prior to transfer of the supernatant after the extended sludge washing process. Development in FY 1998 and FY 1999, combined with the testing of the current system at SRS in FY 1998, would set the stage for a decision on deployment of an acoustic system in FY 1999 or FY 2000. FETC should consider a contract extension and expansion to support both sites in FY 1998 and SRS beyond FY 1998. The TFA envisions the additional cost of this activity to be about $200K in FY 1998.

- Caustic Recovery and Recycle (TFA Need #637)

  TFA would like FETC to complete and award a contract in FY 1998 to demonstrate the viability of a technique for recovery and recycle of caustic materials. This would involve a demonstration on cold simulants, economic evaluations to prove to DOE that this concept is

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cost effective, and eventually fabrication and installation of a unit for hot demonstration at SRS or Hanford. TFA will provide the necessary support to develop the call and support FETC in the technical review. It is anticipated that this task will require three years, and will have decision points after the cold demonstration, the economic evaluation, and the hot deployment. Cost for the first year is estimated to be $500K.

- Crystalline Silicotitanates (CSTs) for DWPF Recycle Streams (TFA Need #619)

  In FY 1998, we request that FETC compete and award a design contract to design for eventual fabrication of a compact processing unit which could be deployed at SRS to clean the waste stream produced from the scrub of the offgas from the DWPF vitrifier. The Cesium could be removed by CSTs, the mercury could be removed by ion exchange methods developed by the Efficient Separations Program, and the solids could be removed by cross flow filtration which has been demonstrated by SRS. TFA will deliver specifications to FETC for the bid package by December 1998 with an estimated cost of $500K. The Conceptual Design Review would be required within 9 months of initiation of the contract.

- Passive Waste Tank Ventilators (TFA Need #625)

  This program will be a FETC FY 1998 call for proposals with multiple awards for a conceptual design by December 1998. There would be a detailed review conducted by FETC and the TFA for down selecting to two or more contractors. These winners would then complete a final design by mid calendar year 1999. A final review and down sizing will occur in FY 1999. The final selection would be for the construction and demonstration of a full system in FY 2000. The anticipated cost in FY 1998 is $800K.

- NDE for Hanford Waste Tanks (TFA Need #663)

  It is the recommendation of TFA that the existing contract with Oceaneering should be completed with radiation hardening of the end effector in FY 1998. TFA is anticipating the development of a request for proposal expanding (or modifying) the existing system concept to include a capability for examination below a liquid level and in small tank annular spaces. By the end of FY 1998, TFA will provide technical specifications for an request for proposals (RFP), which would be funded by FETC in FY 1999. The expected cost is approximately $400K in FY 1999.

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- Tank Evaporation Monitoring (TFA Need #683)

  A high-accuracy psychometric and flow measurement system that will lead to improved determination of the tank evaporation rate and better detection of entrapped gases during retrieval is needed. During FY 1998, the TFA will develop technical specifications for this system and deliver it to FETC for a February 1998, call for proposals. It is not clear that industry has the capability to design and build this system, which would be the thrust of the initial request, capability statements. If a vendor were identified, ultimately, this system would need to be field qualified and integrated into current ventilation system designs. This integration role would be provided by the TFA working in concert with FETC, vendor and site user.

- Unplug Waste Transfer Lines (TFA Need #616)

  The TFA will work with a University partner during FY 1998 to develop technical specifications for a FY 1999 call for proposals. The specifications will be delivered to FETC by the end of FY 1998 or earlier to support an early FY 1999-work initiation. It is anticipated that the first full year of the contract will cost approximately $900K.

- Tank Leak Detection and Mitigation (TFA Need #681)

  The TFA recommends a two-phase procurement, with three separate tasks. The first phase would consist of two scoping/assessment tasks. One task would be focused on tank leak detection, while another task would focus on tank leak mitigation. The same performer would conduct both of these tasks in Phase 1 of the contract. Participants in Phase 1 (per the RFP statement) will not be allowed to participate in Phase 2's technology development. Phase 1 would be initiated late in FY 1998. Pending the result of Phase 1, an industry RFP would be let for development and testing of detection and mitigation systems. Phase 2 would be a FY 1999 contract start.

  In keeping with our agreements, TFA will provide technical specifications necessary to support FETC's format for RFP. It is our understanding that your office will provide a copy of the technical specification requirements to TFA as soon as possible. We have received the GANT chart you developed that depicts our mutual schedule for placing and conducting the contracts. The TFA Technical Team is reviewing these and will provide comments back shortly. In addition, TFA would like an overall listing of TFA-related projects for FY 1998 that FETC is considering supporting. The list should include projected budget, priority, lead, and key decision points for ongoing and new starts. This listing will ensure that we understand the information you need from TFA and that TFA can provide input on budget priorities. Once the RFPs are issued by FETC, the TFA (in keeping

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with our industry protocol that your office endorsed) will provide technical reviewers to support the proposal evaluations. Additionally, the TFA will provide a lead technical individual to support your Contractor Technical Representative for each TFA project.

We look forward to working with the FETC and believe that together we have already set the pace for what will be a very successful year. If you have any questions, please contact me on (509) 372-4546 or Lance Mamiya, Project Execution Manager, TFA on (509) 372-4033.

Billie M. Mauss

Jeffrey A. Frey, Program Manager
Tanks Focus Area

cc: D. W. Geiser, EM-52
K. D. Gerdes, EM-53
P. W. Lurk, EM-5421
R. Bedeck, FETC

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Appendix D - Who's Who

This appendix provides the names of many Tanks Focus Area (TFA) team members. Additionally, more TFA information and other points of contact may be found on the Internet:

- Office of Science and Technology Tanks Home Page at: http://em-52.em.doe.gov/ifd/tanks/tanks.htm
- TFA Technical Team Home Page at: http://www.pnl.gov/tfa/. This home page also contains an extensive TFA contacts list.

TFA Management Team

Tom Gutmann, Site Representative, EM-30, DOE-SR, Aiken, SC
Cathie Louie, Site Representative, EM-30, DOE-RL, Richland, WA
Jacquie Noble-Dial, Site Representative, EM-50, DOE-OR, Oak Ridge, TN
Gene Woodall, Site Representative, EM-30, DOE-ID, Idaho Falls, ID
Dave Geiser, TFA HQ Program Manager, EM-50, DOE-HQ
Cavanaugh Mims, EM-40, DOE-OR, Oak Ridge, TN
Ken Picha, EM-30, DOE-HQ

TFA DOE-RL Integration Team

Jeff Frye, TFA Program Manager, DOE-RL, Richland, WA
Randy Brich, DOE-RL, Richland, WA
Lance Mamiya, Program Execution Manager, DOE-RL, Richland, WA
Billie Mauss, Program Development Manager, DOE-RL, Richland, WA

TFA Technical Team

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Bob Allen, Technical Program Integration Manager, Pacific Northwest National Laboratory, Richland, WA
Tom Brouns, Technical Integration Coordinator, Pacific Northwest National Laboratory, Richland, WA
Kristin Manke, Communications, Pacific Northwest National Laboratory, Richland, WA
Steve Schlahta, Business Operations Manager, Pacific Northwest National Laboratory, Richland, WA
Strategic Integration Coordinator (Position Vacant)

Technical Integration Managers

Pete Gibbons, Retrieval TIM, Numatec Hanford Company, Richland, WA
Bill Holtzscheiter, Immobilization TIM, Westinghouse Savannah River Company, Aiken, SC
Jim Lee, Closure TIM, Sandia National Laboratories, Sandia, NM
Phil McGinnis, Pretreatment TIM, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, TN
Harold Sullivan, Safety TIM, Los Alamos National Laboratory, Los Alamos, NM
Tom Thomas, Characterization TIM, Lockheed Martin Idaho Technologies Company, Idaho National Engineering and Environmental Laboratory, Idaho Falls, NM

TFA User Steering Group

Allen Croff, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, TN
Jim Honeyman, Lockheed Martin Hanford Corporation, Richland, WA
Arvid Jensen, Lockheed Martin Idaho Technologies Company, Idaho National Engineering and Environmental Laboratory, Idaho Falls, NM
Jerry Morin, Westinghouse Savannah River Company, Aiken, SC
Tom Hirons, Los Alamos National Laboratory, Los Alamos, NM
Rod Quinn, Pacific Northwest National Laboratory, Richland, WA
James Rice, Sandia National Laboratories, Albuquerque, NM

TFA Technical Advisory Group

Group Chairman, Wally Schulz, W²S Company, Inc., Albuquerque, NM
Deputy Chairman, Jimmy Bell, Bell Consultants, Inc., Kingston, TN

Pretreatment Subgroup
Subgroup Chairman, Jimmy Bell, Bell Consultants, Inc., Kingston, TN
John Swanson, Private Consultant, Richland, WA
Major Thompson, Westinghouse Savannah River Company, Aiken, SC
George Vandergrift, Argonne National Laboratory, Argonne, IL

Characterization Subgroup
Subgroup Chairman, Gary Eller, Los Alamos National Laboratory, Los Alamos, NM
Dawn Kaback, Colorado Center for Environmental Management, Denver, CO
Bruce Kowalski, University of Washington, Seattle, WA

Immobilization Subgroup
Subgroup Chairman, Tom Weber, Private Consultant, Kennewick, WA
Joseph Gentilucci, JAG Technical Services, Inc., Aiken, SC
William Prindle, Private Consultant, Santa Barbara, CA

Retrieval Subgroup
Subgroup Chairman, Paul Scott, Pacific Northwest National Laboratory, Richland, WA
Robert Erdmann, Attorney, Grass Valley, CA
Brenda Lewis, Westinghouse Savannah River Company, Aiken, SC

At-Large Members
John Carberry, Dupont, Wilmington, DE
Gregory Choppin, Florida State University, Tallahassee, FL
Larry Tavlarides, Syracuse University, Syracuse, NY

Appendix E - Acronyms, Abbreviations, and Glossary

This appendix provides a list of acronyms and abbreviations and a glossary of terms that are used in this Multiyear Program Plan. Both lists are organized alphabetically.

Acronyms and Abbreviations

BDAT	best demonstrated available technology
BVEST	Bethel Valley Evaporator Service Tanks
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSEE	Confined Sluicing End-Effector
CsRD	Cesium Removal Demonstration
CMST	Characterization, Monitoring, and Sensors Technology
CPT	cone penetrometer
CPU	compact processing unit
Cr	chromium
CST	crystalline silicotitanate
CUF	cells unit filter
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DST	double-shell tank
DWPF	Defense Waste Processing Facility
EM	Office of Environmental Restoration and Waste Management (DOE)
EM-30	Office of Waste Management (DOE)

EM-40	Office of Environmental Restoration (DOE)
EM-50	Office of Technology Development (DOE)
ESP	extended sludge processing
ESW	enhanced sludge washing
ETF	Effluent Treatment Facility
FETC	Federal Energy Technology Center
F&R	functions and requirements
FY	fiscal year
GAAT	gunite and associated tanks
GRE	gas release event
HAW	high-activity waste
HEPA	high-efficiency air particulate (filter)
HLW	high-level waste
HTI	Hanford Tanks Initiative
ICPP	Idaho Chemical Processing Plant
ILAW	immobilized low-activity waste
INEEL	Idaho National Engineering and Environmental Laboratory (Idaho Falls, Idaho)
ITP	in-tank precipitation
LAW	low-activity waste
LDUA	Light-Duty Utility Arm
LLW	low-level waste
MLDUA	Modified Light-Duty Utility Arm

MVST	Melton Valley Storage Tank
MYPP	multiyear program plan
NDE	non-destructive evaluation
NDT	non-destructive testing
OHF	Old Hydrofracture Facility
O&M	operations and maintenance
ORR	Oak Ridge Reservation (Oak Ridge, Tennessee)
OTE	Out-of-Tank Evaporator
PHA	precipitate hydrolysis aqueour
PUF	pressurized unsaturated flow
REDOX	reduction-oxidation
RFP	request for proposal
ROD	record of decision
SBW	sodium-bearing waste
SCFA	Subsurface Contaminants Focus Area
SLS	solid-liquid separation
SREX	strontium extraction
SRS	Savannah River Site (Aiken, South Carolina)
SST	single-shell tank
STCG	Site Technology Coordinating Group
TAG	Technical Advisory Group
TBP	tetraphenylborate
Tc	technetium

T_L	liquidus temperature
TFA	Tanks Focus Area
TGA	thermo gravimetric analysis
TMS	topographical mapping system
TPA	Tri-Party Agreement
TRU	transuranic (waste)
TRUEX	transuranic extraction
TSR	technical safety requirements
TTP	technical task plans
USG	User Steering Group
WAP	waste acceptance product specification
WIPP	Waste Isolation Pilot Plant

Glossary

baseline

A quantitative definition of cost, schedule, and technical performance that serves as a base or standard for measurement and control during the performance of an effort; the established plan against which the status of resources and the effort of the overall program, field programs, projects, tasks, or subtasks are measured, assessed, and controlled. Once established, baselines are subject to change control procedures.

calcine

The solid product resulting from high temperature processing (i.e., calcination) that is used at INEEL for processing and solidifying high-level waste.

coordinate

Work that is informally integrated, where the relevance of related tasks is acknowledged by sharing data and/or facilities.

crosscutting program

A program that manages common technology needs across the sites.

developers

An organization or principal investigators responsible for development of new technologies, concepts, or scientific investigation.

double-shell tank (DST)

A reinforced concrete underground vessel with two inner steel liners that provide containment and backup containment of liquid waste; annulus (space between the two liners) is configured to permit detection of leaks from the inner liner.

EM Science Program

A national program created in 1995 by the 104th Congress to stimulate research and development to seek new and innovative methods for DOE's environmental management problems. The program is coordinated between DOE EM-50 and DOE Energy Research.

Hanford Tank Waste Remediation System

EM-30 program responsible for management of high-level tank waste remediation at Hanford.

high-level waste (HLW)

High-level radioactive waste is defined in the *Nuclear Waste Policy Act of 1982* (PL 97-425) as "(A) the highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and (B) other highly radioactive material that the [Nuclear Regulatory Commission], consistent with existing law, determines by rule requires permanent isolation."

leverage

Work that is formally integrated by linking technical task plans or activity data sheets across organizations.

low-level waste

Low-level radioactive waste is defined in the *Nuclear Waste Policy Act of 1982* (PL 97-425) as "radioactive material that (A) is not high-level radioactive waste, spent nuclear fuel, transuranic waste, or by-product material...; and (B) the [Nuclear Regulatory Commission], consistent with existing law, classifies as low-level radioactive waste." Byproduct material is defined in the *Atomic Energy Act of 1954* [42 U.S.C. 2014(e)(2)] as "(1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content."

multiyear program plan (MYPP)

A document that includes high-level descriptions of planned scope, schedule, and budget for a period of several years. For the Tanks Focus Area MYPP, the recommended technical elements are described and preliminary funding estimates are provided. The MYPP defines the Tanks Focus Area technical program and provides the basis for requests for proposals. The MYPP is reviewed at least annually to determine if changes are necessary.

producers

Manufacturers or suppliers of technology.

risk

The combined result of the probability and consequences of failure of an item expressed in quantitative terms.

saltcake

The crystalline water-soluble solids in waste tanks.

single-shell tank

One of 149 single-shell carbon steel tanks (ranging in size from 55,000 to 1,000,000 gal) that have been used to store high-level radioactive waste at the Hanford Site.

Site Representatives

DOE employee from user programs at each of the tank sites within TFA's purview that is a member of the TFA Management Team.

Site Technology Coordination Group (STCG)

A group consisting of stakeholders, users, and U.S. Department of Energy representatives at each of the four tank sites (currently being formed). The group is responsible for coordinating regulatory and stakeholder interfaces at each tank site and facilitation of the interactions among these groups and the TFA technical team.

sludge

A thick layer containing chemicals that have precipitated or settled to the bottom of a tank. Sludge can be difficult to pump.

stakeholders

People and organizations involved in making decisions about the remediation of tank waste. Stakeholders may include impacted Native American tribes, U.S. Environmental Protection Agency, U.S. Department of Energy, and many others.

supernate

The upper layer of salts in a waste tank dissolved in water.

Tanks Focus Area (TFA)

The mission of this DOE focus area is to manage an integrated technology development program that results in the application of technology to safely and efficiently accomplish tank remediation across the DOE complex.

technology development

The process of applying science to achieve commercial objectives and to solve technical problems. Technology development includes conceiving of new ideas, proof-of-principle testing, bench-scale testing, pilot-scale testing, and technology

transfer activities necessary for technology application. Note that not all of these activities may be performed for the development of a particular technology and that technology development activities are considered complete when a technology has been selected for technology application.

TFA Implementation Team

The mission of this team was to develop the implementation plan and for directing the management team. This team was led by the U.S. Department of Energy, Richland Operations Office and consisted of seven contractors and national laboratories (of which Pacific Northwest Laboratory was the lead) and the User Steering Group.

TFA Management Team

This team is responsible for setting policy and providing direction, guidance, and performance measures to the Tanks Focus Area. This team consists of representatives from U.S. Department of Energy-Headquarters and operations offices at Idaho, Oak Ridge Reservation, Richland (Hanford), and Savannah River Site.

TFA Technical Advisory Group (TAG)

A group consisting of technical experts in each of the primary program areas from national laboratories and universities. The group is responsible for reviewing both processes and products of the TFA Technical Team.

TFA Technical Team

A group consisting of the Technical Integration Coordinator, the Technology Integration Managers, Technical Team Managers, Program Integration Manger, Technical Operations Coordinator, Strategic Initiatives Coordinator, and support staff, and ad hoc technical experts.

transuranic (TRU) waste

TRU waste is defined in the *Atomic Energy of 1954* [42 USC 2014(ee)] as "material contaminated with elements that have an atomic number greater than 92, including neptunium, plutonium, americium, and curium, and that are in concentrations greater than 10 nanocuries per gram, or in such other concentrations as the Nuclear Regulatory Commission may prescribe to protect the public health and safety."

TRU waste is primarily generated by research and development activities, plutonium recovery, weapons manufacturing, environmental restoration, and decontamination and decommissioning. Most TRU waste exists in solid form

(e.g., protective clothing, paper trash, rags, glass, miscellaneous tools, and equipment). Some TRU waste is in liquid form (sludges) resulting from chemical processing for recovery of plutonium or other TRU elements.

User Steering Group (USG)

A group consisting of senior managers of the four site tank remediation programs. The USG is responsible for 1) assisting in establishing effective technical support networks and work locations at the sites, 2) approving this multiyear program plan and the fiscal year work plan, and 3) actively supporting the transitioning of current site-based technology programs to the Tanks Focus Area and then transferring demonstrated technologies back to the sites.

users

Staff and organizations located at the four waste tank sites responsible for managing the wastes.

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