Multiyear Program Plan FY01-FY05

September 2000

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PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

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**Available to DOE and DOE contractors from the
Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831;
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**Available to the public from the National Technical Information Service,
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PNNL-13339
UC-600

TFA Multiyear Program Plan FY01-FY05

September 2000

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Acronyms and Abbreviations

AEAT	AEA Technology
AM	Assistant Manager
ANL	Argonne National Laboratory
ASTD	Accelerated Site Technology Deployment
BVEST	Bethel Valley Evaporator Service Tank
BBWI	Bechtel BWXT Idaho, LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHG	CH2M Hill Hanford Group
CIF	Consolidated Incineration Facility
CMST	Characterization, Monitoring, and Sensor Technology Crosscutting Program
CNDE	Center for Non-Destructive Evaluation
CRB	Corporate Review Budget
CST	crystalline silicotitanate
CUF	cells unit filter
D&D	decontamination and decommissioning
DDFA	Deactivation and Decommissioning Focus Area
DIAL	Diagnostic Instrumentation & Analysis Laboratory
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy – Headquarters
DOE-ID	U.S. Department of Energy – Idaho Operations Office
DOE-OH	U.S. Department of Energy – Ohio Field Office
DOE-OR	U.S. Department of Energy – Oak Ridge Operations
DOE-ORP	U.S. Department of Energy – Office of River Protection
DOE-RL	U.S. Department of Energy – Richland Operations Office
DOE-SR	U.S. Department of Energy – Savannah River Operations Office
DOE-WVDP	U.S. Department of Energy – West Valley Demonstration Project
DST	double-shell tank
DWPF	Defense Waste Processing Facility
ECR	effective cleaning radius
EIS	Environmental Impact Statement
EM	Office of Environmental Management (DOE)
EM-20	Office of Integration and Disposition (DOE)
EM-30	Office of Site Closure (DOE)
EM-40	Office of Project Completion (DOE)
EM-50	Office of Science and Technology (DOE)
EM-54	Office of Technology Applications (DOE)
EMSP	Environmental Management Science Program
EN	electrochemical noise
EPA	Environmental Protection Agency
ESP	1) Efficient Separations and Processing Crosscutting Program, 2) Environmental Simulation Program
ESW	enhanced sludge washing
FFA	Federal Facilities Agreement
FIU	Florida International University

FY	fiscal year
GAAT	Gunite and Associated Tanks
HAW	high-activity waste
HEPA	high-efficiency particulate air (filter)
HFIR	High Flux Isotope Reactor
HLW	high-level waste
ILAW	immobilized low-activity waste
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IPL	Integrated Priority Listing
IRB	Internal Review Budget
LA/MS	laser ablation/mass spectrometry
LANL	Los Alamos National Laboratory
LAW	low-activity waste
LDUA	Light-Duty Utility Arm
LLW	low-level waste
LRF	laser range finder
LVDG	low-volume density gradient
M&I	management & integration
MLDUA	Modified Light-Duty Utility Arm
MLLW	mixed low-level waste
M&O	management and operations
MOU	memorandum of understanding
MST	monosodium titanate
MVST	Melton Valley Storage Tank
MYPP	multiyear program plan
NDE	nondestructive examination
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
NHC	Numatec Hanford Corporation
NRC	U.S. Nuclear Regulatory Commission
OBG	Old Burial Grounds
OHF	Old Hydrofracture Facility
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OST	Office of Science and Technology
PBI	Performance Based Initiative
PBS	Project Baseline Summary
PEG	Program Execution Guidance
PHMC	Project Hanford Management Contract
PI	principal investigator
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
RBX	Robotics Crosscutting Program
RCRA	Resource Conservation and Recovery Act
REDOX	reduction-oxidation
RFP	request for proposal

ROD	Record of Decision
SBW	sodium-bearing waste
SCFA	Subsurface Contaminants Focus Area
SNL	Sandia National Laboratories
SPP	Salt Processing Project
SREX	strontium extraction
SRS	Savannah River Site
SRTC	Savannah River Technology Center
SST	single-shell tank
STCG	Site Technology Coordination Group
TAG	Technical Advisory Group
TFA	Tanks Focus Area
TIM	Technology Integration Manager
TMS	Technology Management System
TPB	tetraphenylborate
TRU	transuranic (waste)
TRUEX	transuranic extraction
TTP	Technical Task Plan
TWRS	Tank Waste Remediation System
USG	User Steering Group
UT-Battelle	University of Tennessee – Battelle
WAPS	waste acceptance product specification
WSRC	Westinghouse Savannah River Company
WVDP	West Valley Demonstration Project
WVNS	West Valley Nuclear Services

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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 68 tanks are known or assumed to have leaked contamination to the soil. 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 Office of Environmental Management's (EM's) national science and technology development program for radioactive waste tank remediation. The national program was formed to increase integration and realize greater benefits from DOE's science and technology development budget. The TFA is responsible for managing, coordinating, and leveraging science and technology development activities across the DOE complex to support DOE's five major tank sites: the Hanford Site in Washington, the Idaho National Engineering and Environmental Laboratory (INEEL) in Idaho, Oak Ridge Reservation (ORR) in Tennessee, the Savannah River Site (SRS) in South Carolina, and West Valley Demonstration Project (WVDP) in New York. While not one of the five "official" TFA tank sites, the TFA also supports the Fernald Environmental Management Project (Fernald) in Ohio, by providing technical assistance, as needed. In FY00, TFA conducted an independent review of retrieval system designs for Fernald.

TFA's technical scope covers the major functions that comprise a complete tank remediation system: waste retrieval, waste pretreatment, waste immobilization, tank closure, and characterization of the tank wastes, with safety integrated into all the functions. The TFA integrates program activities across EM organizations that fund tank science and technology development, including the Offices of Integration and Disposition (EM-20), Site Closure (EM-30), Project Completion (EM-40), and Science and Technology (EM-50 or OST).

The TFA depends heavily upon site users to participate in the TFA's multiyear planning process and program execution. One of the key TFA organizational elements is the Management Team, led by DOE's Richland Operations Office (DOE-RL) and composed of federal user representatives from each of the five sites, plus DOE-Headquarters (DOE-HQ). The Management Team conducts weekly program updates, determines program policy, and performs program prioritization and oversight. Through its DOE-HQ and site members, the TFA communicates with the HLW Steering Committee consisting of assistant managers from each of the five sites and DOE-HQ managers with radioactive tank waste remediation management responsibility.

For technical issues, Pacific Northwest National Laboratory (PNNL) leads the TFA Technical Team. The Technical Team includes PNNL and six contractor and national laboratory partners. A User Steering Group (USG) consisting of senior contractor user members, and three non-user members representing laboratories that participate on the team, provides additional user representation to the program. Through

its own technical review body, the Technical Advisory Group (TAG), the TFA receives responsive high-quality, independent technical reviews.

Together, all the components of the TFA team execute a mission to deliver and work with users to implement technical solutions using an integrated approach to safely and efficiently accomplish tank waste remediation across the DOE complex. Inherent in the TFA mission, the TFA seeks to

- Provide technical solutions to enable and enhance remediation.
- Respond to the unique technical challenges inherent in the program's mission.
- Work with users and program partners throughout the entire process, from problem identification to implementation of technical solutions.
- Focus on filling technical gaps and making tangible progress toward solving key tank problems.

To accomplish this mission, the TFA's goals include working to increase the use of EM-50 funded results, reduce programmatic and technical risk, and direct a portion of the program to contingency or alternative technology approaches. Several strategies are required to support the TFA's mission and goals. Providing technical assistance, technology evaluation and screening, delivering data and recommendations, deploying technologies, and communicating successes and lessons learned are among the key supporting strategies.

This multiyear program plan (MYPP) reflects the TFA's plan for the next five fiscal years (FY01-FY05). Most of the planning emphasis is on FY01 and FY02. During this period, the TFA plans major work in seven key areas. Safety and Characterization, because it cuts across the other seven areas, is described, as appropriate, within these areas:

1. Safe waste storage
2. Waste mobilization and retrieval
3. Conditioning, transfer, and retrieval-pretreatment integration
4. Interim storage
5. Waste pretreatment
6. Waste immobilization
7. Closure.

Safe Waste Storage. Investments in safe waste storage are needed to fill technical gaps, reduce costs, and avoid costly problems, while ensuring protection of the public and environment. Priority site needs are focused on science and technology to 1) improve tank integrity monitoring and corrosion prevention, 2) improve tank ventilation, 3) improve waste characterization, and 4) reduce the volume of waste entering the tank farm through source and recycle stream waste reduction.

The TFA's near-term goal for assisting sites in avoiding tank corrosion is to improve upon methods for maintaining tank waste chemistry within site specifications by adapting commercial monitors for in-tank analysis of inhibitors and major species that control corrosion rate. The longer-term goal for addressing tank corrosion 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. The strategy for evaluating tank integrity also includes near- and longer-term goals. Commercial nondestructive examination (NDE) techniques will be deployed near term using an arm-

based or crawler-based system to inspect tank walls. Longer-term efforts will integrate needs from multiple sites to define, develop, and test the specific systems needed to inspect tank floors, inspect surfaces below a liquid level, and assess a tank's integrity before reuse or waste retrieval.

The TFA is making a strategic investment to develop a methodology for evaluation of stable, interim waste tank configurations for the period between formal waste retrieval activities and final tank closure. To reduce the cost of active tank ventilation, the TFA is investing in regenerable filter systems and exploring commercial filtration technologies for high-temperature applications. Waste characterization investments include tools and methods to characterize waste in situ to support sludge and supernate processing at Hanford, SRS, and ORR. Investments are targeted at source and recycle waste stream volumes at SRS's liquid effluent treatment facility, mercury and chlorides removal at INEEL, and other waste minimization opportunities at INEEL.

Waste Mobilization and Retrieval. Improved or new methods to mobilize wastes and detect and mitigate leaks during waste retrieval operations constitute the TFA's major areas of emphasis in waste mobilization and retrieval. The TFA will continue its investigation of improved mixing and pumping technologies, including potential developments available from Russia. The sites' concerns with waste leakage during retrieval operations are being addressed through a wide range of TFA activities that include improved control of water during retrieval, technologies for detecting leaks, and leak mitigation techniques in the event a leak is detected. In addition, TFA will make strategic investments to 1) improve retrieval processes by chemical or other adjustments to reduce solids and particle sizes, and 2) evaluate methods for retrieving wastes from potentially leaking tanks.

Conditioning, Transfer, and Retrieval-Pretreatment Integration. The sites face several problems after waste is retrieved but before pretreatment. The TFA will continue its investigation of waste re-precipitation, solids formation, waste transfer line plugging, and waste settling. This work includes providing technologies to facilitate the transfer of wastes among tanks and to waste treatment facilities. Thermodynamic and kinetic laboratory studies will increase the knowledge of waste characteristics and properties during the time between retrieval and pretreatment. These studies should produce results that have implications on both retrieval and pretreatment operations.

Interim Storage. Interim storage enables the storage of wastes as dry materials. TFA investments in this area are focused on INEEL's calcine wastes, including characterization, retrieval, and dissolution.

Waste Pretreatment. Waste pretreatment is used to separate radionuclides into small volumes of HLW (which require expensive immobilization and disposal), while leaving the majority of chemical wastes for less costly disposal as low-activity waste. The TFA's investments include clarifying liquid streams through solid-liquid separations, supernate processing to remove radionuclides, and sludge processing to remove excess chemical species that either increase the volume of HLW or adversely impact the performance of the HLW form. Critical areas of focus include the selection of a new Cs and ion exchange treatment, salt processing system at SRS, and processing options for INEEL. The TFA is making a strategic investment to evaluate methods for removing from the waste chemicals such as chromium, phosphate, sulfate, and mercury that can have negative impacts on down-stream vitrification and processing. In addition, the TFA is supporting the Technical Working Group, led by EM's Office of Project Completion, by providing direct oversight and management of the research and development activities related to the SRS Salt Processing Project.

Waste Immobilization. Waste immobilization includes LLW immobilization, secondary waste treatment, and HLW immobilization. Investments in this area are focused on reducing costs and enhancing the baseline at SRS, as well as filling technical gaps in the baselines for Hanford and INEEL. For LLW immobilization, TFA will invest in the establishment of baseline processes for INEEL LAW immobilization and in treatment plans for Hanford and ORR LLW. Investments will be made in refining HLW processing improvements at SRS to reduce costs, and at INEEL and Hanford to reduce technical risks. A strategic investment will be made to evaluate the induction-heated, cold crucible melter technology for waste streams that may benefit from higher melting temperatures for waste vitrification. Other investments include obtaining data to support design of LLW disposal systems, methods and data to support disposition of secondary wastes from HLW processing, and remote tools for efficient operation and maintenance in a radioactive environment.

Closure . The TFA will continue to assist sites in stabilizing and closing their tanks. Based upon past success in grouting operations, the TFA will continue to invest in improved grout formulations and bases for tank closure. Investments will also be made in delivery methods to improve performance for immobilizing residual tank waste and stabilizing tanks at SRS and ORR. The TFA integrates a wide range of activities from other EM-50 programs directed at solving these problems. These activities include characterization, retrieval, and in situ grouting systems.

To support all of the work summarized above, the TFA, in concert with the user community it serves, developed technical approaches to solve problems and to define the supporting funding requirements. Table ES.1 presents a 5-year funding summary for technical work (does not include management costs). Formulation of this funding summary began with the development of technical responses to site needs received during FY00. The stated FY01 funding is the approved TFA budget total. The FY02 funding consists of the approved FY02 Corporate Review Budget (CRB) at the Target Level. The FY03 - FY05 totals are the result of a functional analysis of expected future requirements based on baseline assumptions and present site needs.

Table ES.1. TFA and Other OST Funding, FY01-FY05

	FY01	**FY02**	**FY03**	**FY04**	**FY05**
TFA	$32.015M	$41.455M	$43.62M	$41.7M	$42.05M
Other EM-50	$8.675M	$12.65M	$13.0M	$14.2M	$13.5M
EM-50 TFA Total	$40.690 M	$54.105 M	$56.620 M	$55.950 M	$55.550 M

With its users, the TFA revisits its program requirements each year and routinely makes program adjustments when new requirements are identified or when previous requirements become satisfied or are no longer a priority.

Section 1.0 Introduction and Background

1.1 Introduction

This MYPP presents the planned TFA technical program. The plan provides a 5-year funding outlook (FY01-FY05), with an emphasis on FY01 and FY02. The MYPP describes the tank waste remediation problem and TFA's role in solving it (Section 1.0), the TFA's vision and mission (Section 2.0), the goals and strategies required for TFA to succeed (Section 3.0), the TFA's focus area-centered program components (Characterization, Monitoring, and Sensor Technology [CMST] Crosscutting Program; Efficient Separations and Processing [ESP] Crosscutting Program; Robotics [RBX] Crosscutting Program; Accelerated Site Technology Deployment [ASTD] Program; Environmental Science Management Program [EMSP]; and Industry, University, and International Programs) (Section 4.0), the TFA's technical program (Section 5.0), and references used in the work (Section 6.0).

As supporting material, this report contains the TFA's organization (Appendix A), site needs and TFA's response to those needs (Appendix B), a description of the TFA's prioritization process (Appendix C), major milestones (Appendix D), performance indicators planned for FY01-FY05 (Appendix E), focus area-centered program components' technical work (Appendix F), descriptions of the five major tank sites (Appendix G), technical reviews (Appendix H), and a glossary (Appendix I).

The Annual Performance Plan, a companion document to this MYPP, will be presented at a later date.

1.2 Problem Description

Remediation of tanks containing highly radioactive waste is a major technical and programmatic challenge for the DOE (Stewart et al. 1997). The DOE system currently stores about 340 million liters (90 M gallons) of waste containing more than 700 million curies (MCi) in 282 tanks at five major sites:

- SRS near Aiken, South Carolina, has 51 tanks (two closed) storing 125 million liters (33 M gallons) of waste containing about 470 MCi of radioactivity.
- In Washington State, the Hanford Site has 177 tanks that store 204 million liters (54 M gallons) of waste containing about 200 MCi of radioactivity.
- INEEL near Idaho Falls, Idaho, has 11 tanks with 5.3 million liters (1.4 M gallons) of liquid waste containing 520,000 Ci of radioactivity and 3.8 million liters (1 M gallons) of calcined (a granular powder) waste with 24 MCi of radioactivity stored in seven bin sets.
- ORR in Oak Ridge, Tennessee, has about 1.6 million liters (430 K gallons) of legacy waste containing 47,300 Ci of radioactivity in 40 tanks. ORR also annually adds approximately 56,000 liters (1500 gallons) of active waste containing 13,000 Ci of radioactivity to 13 of their tanks.
- WVDP near West Valley, New York, has retrieved and vitrified approximately 98% of the 2.3 million liters (600 K gallons) of waste that was stored in 3 tanks. Of the original 23.7 MCi, only 600,000 Ci remain in the tanks.

In addition to the 282 tanks within the TFA's purview, each site also contains miscellaneous storage tanks.

The tank wastes are chemically and physically heterogeneous between sites, between tanks on a given site, and in some cases, between the phases of waste within a single tank. Tank wastes at Hanford, SRS, ORR, and WVDP are alkaline. At Hanford and SRS, these wastes resulted from chemical separations operations required to produce plutonium. Hanford performed several different separations processes over the years of plutonium production, and additional operations such as uranium, cesium, and strontium recovery. As a result, there are several different waste types at Hanford. WVDP wastes were generated from commercial reprocessing of uranium and plutonium from spent nuclear fuel. ORR wastes are similar in composition to some of the wastes at Hanford and SRS; during World War II, ORR developed and demonstrated many of the chemical separations processes used at those sites. INEEL's waste type is unique within the DOE system in that it is stored in an acidic form. The majority of INEEL's waste has been calcined (converted to a dry, granular powder), which is considered an interim storage form by the State of Idaho. Calcine waste requires further processing to convert it to a more durable long-term waste form. In addition, the INEEL has some tank heel waste remaining that must be addressed (see Appendix G for more details). Much of the waste at Hanford, SRS, and WVDP is classified as high-level waste (HLW).[a] The waste at INEEL is divided into two categories: high-level liquid waste and sodium-bearing waste. The waste at ORR is mixed low-level waste (MLLW) or TRU (Schulz, 1998).[b,c]

To protect the public, workers, and the environment, this radioactive waste must be safely stored, retrieved from the tanks, and converted into an appropriate form for long-term disposal. DOE has signed Federal Facility Agreements (FFAs) with state and federal regulators that drive the scope and schedule for cleanup and closure of the tanks. Based on DOE's "Status Report on Paths to Closure" (DOE 2000) and the original document "Accelerating Cleanup: Paths to Closure" (DOE 1998) that outlines the activities, cost, and schedule for EM cleanup, the HLW mission area represents the highest cost driver for EM (nearly one-third of the total life-cycle cost). In addition, HLW remediation is a long-term problem, with greater than 70% of the cost to be incurred after 2006. The life-cycle cost for HLW remediation through 2070 is estimated as $55B. Cost, schedule, number of waste streams, and number of Project Baseline Summaries (PBSs) with urgent or high technical risk and high visibility are summarized for each site in Table 1.1.

(a) High-level waste is defined as waste from the reprocessing (chemical separation) of uranium and plutonium from other nondesired radioactive elements. High-level waste contains most of the radioactive elements discharged as waste to the underground tanks.

(b) Mixed waste contains both hazardous chemical and radionuclide components. Mixed low-level waste contains hazardous chemicals and low-level waste. Low-level waste is defined as radioactive waste not classified as high-level waste, transuranic waste, spent fuel, or byproduct material.

(c) Transuranic waste has alpha-emitting elements that have atomic numbers greater than 92 with half-lives greater than 20 years in concentrations of more than 1 ten-millionth of a curie per gram (0.03 ounce).

Table 1.1. Summary of Paths to Closure Data on High-Level and Tank Waste Remediation Mission

Site	Cost, $B[a]	Complete Date	Waste Streams	Number of PBS	PBS High Visibility
Hanford Site	32.8	2046	3	10	10
Savannah River Site	14.2	2028	10	13	4
Idaho National Engineering and Environmental Laboratory	5.8	2070	2	5	3
West Valley Demonstration Project	1.9	2015	2	3	2
Oak Ridge Reservation[b]	3.2	2006	2	3	3

References: U.S. Department of Energy. March 2000. *Status Report on Paths to Closure*. DOE/EM-0526, U.S. Department of Energy, Washington, D.C.
U.S. Department of Energy. March 2000. *Project Baseline Summaries.*

(a) Costs accrued from FY97 through completion date.
(b) Non-HLW site. ORR tank remediation costs not included in HLW cleanup totals.

Each site is at a different stage in remediation of wastes and closure of tanks. SRS and WVDP have operating waste immobilization facilities, while Hanford, INEEL, and ORR are designing and preparing for future processing to convert tank wastes into final waste forms for disposal. Hanford and ORR are pursuing contracts for the construction and operation of the processing facilities. ORR and WVDP have retrieved or consolidated the majority of their bulk wastes for treatment and are focused on residuals removal and tank closure. SRS is continuing sludge and heel retrieval for vitrification in the Defense Waste Processing Facility (DWPF) and to continue tank closures. Hanford is also preparing for waste retrieval to support feed delivery to the waste processing contractor, while INEEL is focused on an accelerated schedule to assess the various options for tank waste treatment and facility disposition.

SRS must meet high-level waste canister production schedules by maintaining and improving operations in the DWPF. However, the baseline process for removal of cesium and other radionuclides from retrieved salt solutions (a precursor to DWPF processing of salt waste) was discontinued in 1998 due to technical problems and safety concerns. Therefore, a salt disposition treatment alternative is required to enable future processing and immobilization. Meanwhile, continued retrieval of sludge wastes is required to maintain a non-salt feed to the DWPF. In addition, regulatory commitments require continued efforts to close tanks.

Hanford, under the newly established Office of River Protection, is preparing to retrieve wastes and deliver tank waste feed to a waste processing contractor for pretreatment and immobilization. Hanford must ensure that the waste feed is available, can be delivered on time, and meets contractual requirements. This waste processing contract, known as Phase I, represents treatment of approximately 10% of the site's tank waste by mass. The site will then accept immobilized low activity and high activity waste products from the vendor. A product acceptance strategy is required to ensure vendor products meet regulatory requirements for disposal. Results of Phase I will help define requirements for Phase II, which will process the remaining tank waste. Meanwhile, Hanford must maintain safe storage conditions for wastes in the double- and single-shell tanks. For example, salt-well pumping operations must be

continued to transfer the liquids in the single-shell tanks (SSTs) to double-shell tanks (DSTs), thereby reducing corresponding risks of leakage to the vadose zone.

INEEL must continue efforts to design and test an integrated flowsheet for low-activity waste (LAW) and high-activity waste (HAW) processing to meet the compliance schedule for Title 1 design of treatment facilities. Although all liquid HLW resulting from fuel reprocessing has been converted to a dry form (i.e., calcine) for interim storage, future processing will be required to produce an acceptable final waste form. Flowsheet elements may include dissolution of calcined wastes, separation of TRU elements, cesium, and strontium, and immobilization of the low-activity and high-activity fractions. INEEL is preparing an Environmental Impact Statement (EIS) to provide a basis for selecting technical options to process the INEEL tank waste. Testing of flowsheet unit operations, downselection to preferred options, and integrated design and testing of the pretreatment and immobilization processes are required to support the design schedule. To meet recent consent order requirements, INEEL is also accelerating efforts to treat all the remaining liquid wastes, reduce new waste generation, inspect and permit storage tanks needed for future activities, and to close the HLW tanks not needed for completing the site mission.

ORR is continuing efforts to retrieve and consolidate all tank wastes at a single facility for processing by a private contractor. Retrieval and transfer operations have been completed or are underway for all of the tank farms consistent with regulatory commitments. Continued deployment of mixing, mobilization, heel retrieval, cleaning, waste conditioning, volume reduction, and monitoring technology is required to complete the retrieval, consolidation, and feed delivery efforts. Closure of tanks is required to further reduce mortgages and meet ORR cleanup schedules.

WVDP has completed bulk retrieval and processing of the primary tank wastes and is preparing for closure activities, including decontamination and disposal of waste materials and expended equipment. Glass-contaminated equipment from HLW vitrification operations must be decontaminated to qualify for disposal as low-level waste (LLW). HLW canisters require decontamination to enable off-site shipment and disposal. The site is also completing tank heel retrieval and preparing for tank closure activities to meet compliance schedules and support the development of a final tank closure strategy.

All of the sites require technical assistance, scientific data, technology development, and baseline technology performance verification to improve efficiency, reduce costs, reduce risks, and enable the baseline tank waste remediation and closure activities outlined above to be implemented. While not one of the five "official" TFA tank sites, the TFA also provides technical assistance, as needed, to the Fernald Environmental Management Project (Fernald) in Ohio. In addition, because HLW remediation represents the greatest cost and longest term EM problem, greater potential exists for significant impacts from science and technology developments. Scientific research and applied technology activities focused on longer-term, high-risk and high-cost portions of the HLW processing flowsheets are required to support future decisions on baseline and alternative remediation strategies (NRC 1999).

1.3 Functions to Solve the Problem

Before FY95, responsibility for developing technical solutions to support tank remediation was spread across multiple EM organizations and sites. In January 1994, DOE issued an action plan establishing a new approach for solving complex remediation problems, including highly radioactive

waste tank problems. On April 1, 1994, DOE issued a call for proposals on approaches for transitioning tank technology from a distributed to a focused national effort.

A team of seven contractors and national laboratories responded to and were awarded the responsibility to implement the focus area concept for radioactive waste tanks. This concept includes leadership through a partnership between DOE-RL and PNNL. It also includes partnerships between users and technical experts to define and execute an integrated, focus area-centered program.

This concept has been put into practice for the last six fiscal years. The key attributes of this concept include:

- Integration with users
- Technical centers of excellence
- Focus area-centered concept
- Technical assistance to users.

Integration with users. Both the DOE and the contractor users under EM's Offices of Integration and Disposition, Site Closure, and Project Completion are active members of the TFA. The TFA organization is shown in Figure 1.1, with membership details provided in Appendix A. The TFA Management Team consists of DOE users from the five tank sites and DOE-HQ. Their role is to ensure needs are developed and submitted through the Site Technology Coordinating Groups (STCGs) at their sites, to prioritize the technical responses to those needs, and to help ensure site contractors are incentivized to include TFA technical solutions in their baselines. Additionally, the DOE user members of this team act as liaisons to their managers for Site Closure and Project Completion on specific TFA activities and products.

These managers and DOE-HQ managers with HLW responsibilities comprise the HLW Steering Committee. This committee ensures complex-wide integration on policy and other issues including science and technology. Members of the HLW Steering Committee have been signatories on the TFA MYPP starting in FY97. The combination of the day-to-day management attention from the user program provided through the TFA Management Team and the endorsement of the HLW Steering Committee allows TFA to stay aligned with user needs and schedules. This coordination enables the TFA to deploy and implement key technical solutions, thereby helping EM in resolving tank problems.

Integration with the users also requires active participation with the implementing contractors at each of the sites. As a result, the USG participates with the TFA. The USG is comprised of managers from the five management and integration or management and operations organizations at each of the sites, plus managers from the laboratories that participate on the TFA. This group ensures that the technical and programmatic details required to fully define site needs are provided, that barriers to deployment of technical solutions are mitigated within the contractor organizations, and that site resources are provided to ensure implementation of technical solutions. Integration of the TFA Management Team and the USG into site planning and resource allocation results in delivery and implementation of technical solutions to solve users' key problems.

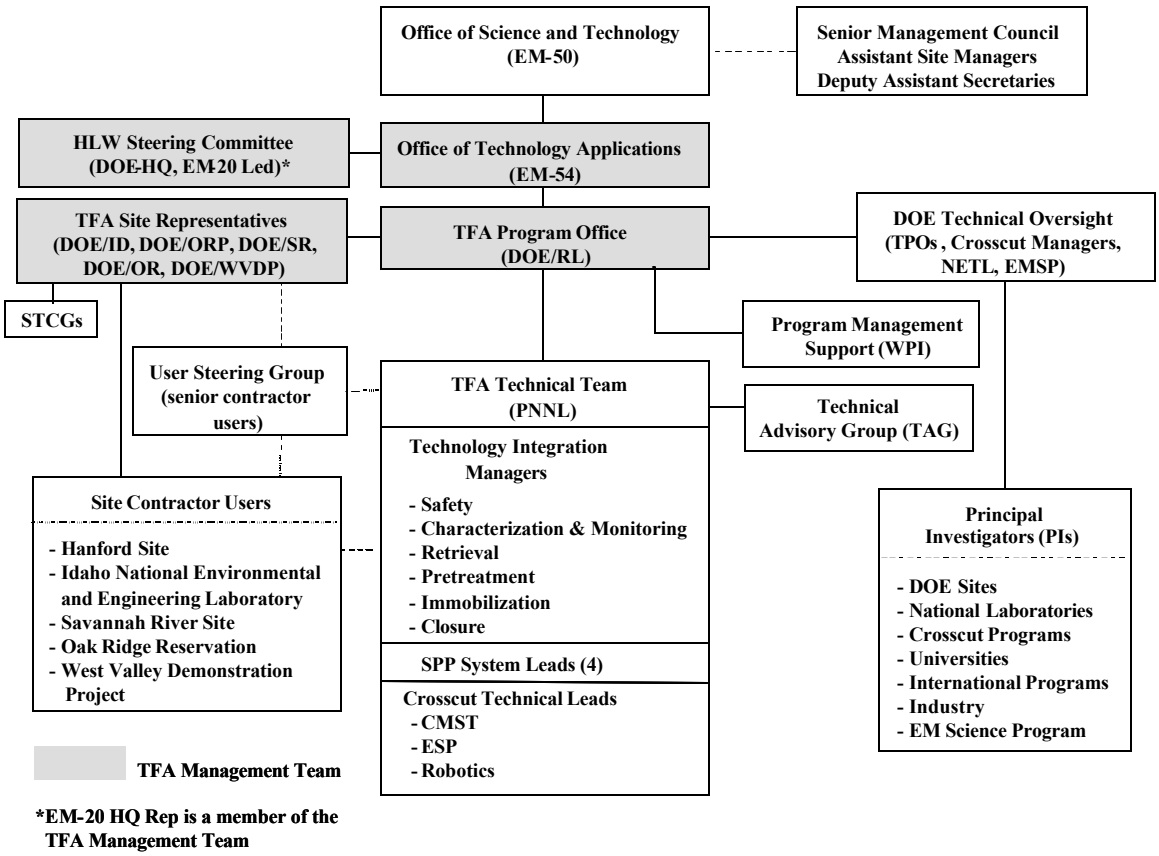

Figure 1.1. Tanks Focus Area Organization

Centers of excellence. The TFA is founded on a partnership between the DOE and the national laboratories to ensure technical excellence in both the translation of a need to a viable technical solution and the execution of the program in a technically sound manner. This partnership is illustrated in Figure 1.1. The TFA Technical Team is led by PNNL and includes six laboratory or government contractor partners that provide technical leaders, called Technology Integration Managers (TIMs), in the key functional areas associated with tank waste remediation: Los Alamos National Laboratory (LANL) provides safety leadership, INEEL provides characterization and monitoring leadership, Numatec Hanford Corporation (NHC) provides retrieval leadership, Oak Ridge National Laboratory (ORNL) provides pretreatment leadership, Westinghouse Savannah River Company (WSRC) provides immobilization leadership, and Sandia National Laboratories (SNL) provides closure leadership. The Technical Team provides the technical expertise and deployment experience required to develop technical scope, maintain technical progress, and ensure delivery of technically responsive products to the user. In addition, the three crosscut programs—CMST, ESP, and RBX—represent additional centers of excellence for the crosscutting areas that support tank waste remediation and other EM mission areas. Crosscut program technical leads work with the TIMs to develop and implement the TFA's technical program.

Focus area-centered. The TFA integrates the activities of nine science and technology-related programs within EM. These programs range from applied research conducted by the EMSP to site programs that focus on site-specific issues. As needs are received, the TFA works to identify not only the appropriate technical response, but also the most qualified program to perform the work scope. The TFA then

ensures coordination of all of the activities from these programs in a way that leads to a single integrated technical solution for the user program. This approach clarifies and tracks the interfaces in a systematic manner, avoids duplication of technical investments, and enables deployment and implementation by providing the coordination required to deliver solutions. In this way, the TFA is the single point of accountability for tank science and technology and acts as a focal point for user interface and science and technology information.

Technical assistance. The network of users and technical experts provided by the TFA organization provides technical assistance to the five tank sites, plus Fernald as needed. Frequent technical exchanges on key topics ensure rapid dissemination of lessons learned as technical solutions and technologies are deployed. This approach has increased the likelihood of multiple deployments.

Moreover, technical experts - including those from the TFA's TAG, which serves to review many aspects of the TFA program - are providing technical assistance through consultation and reviews for key activities as requested by the sites. Recent examples include the assessment of the DOE-ID Draft EIS technical alternatives, the roadmap development and review at INEEL, and the retrieval system design reviews for Fernald. In addition, the TFA is supporting the Technical Working Group, led by EM's Office of Project Completion, by providing direct oversight and management of the research and development activities related to the SRS Salt Processing Project. The TFA will also be conducting a melter study at Hanford in FY01 at the request of the Offices of Project Completion and Science and Technology.

For more information on TFA's major accomplishments, see TFA's Annual Reports. These reports can be found at http://www.pnl.gov/tfa/program/index.stm.

Section 2.0 Vision and Mission

This section describes the TFA's mission and vision within the context of the OST mission. This section also discusses the direct correlation between the five elements of OST's focus area-centered approach and the TFA's mission and operational approach.

2.1 Vision and Mission Statements

The vision of OST (the principal organization responsible for creating and funding the focus areas) is to provide the scientific foundation, new approaches, and new technologies that contribute to significant reductions in risk, cost, and schedule for completing the EM mission. Aligned with OST's vision, the TFA's vision is to enable tank farm closure through the development and application of safe and efficient remediation technologies.

The mission of OST is to manage and direct targeted basic research and focused, solution-oriented science and technology development programs to support EM. Within this mission, the TFA's mission is to

Work with users to deliver, develop and implement technical solutions—through an integrated approach—to safely and efficiently accomplish tank waste remediation at five major DOE sites: Hanford Site, INEEL, ORR, SRS, and WVDP.

Inherent to this mission, the TFA seeks to:

- Provide technical solutions to enable and enhance remediation.
- Respond to the unique technical challenges inherent in the program's mission.
- Work with users and program partners through the entire process, from problem identification to implementation of technical solutions.
- Focus on filling technical gaps and making tangible progress toward solving key tank problems.

2.2 Relation to the Focus Area-Centered Approach

Under the focus area-centered approach, the TFA leads the integration of OST's science and technology efforts that support tank waste remediation. Five key elements distinguish the focus area-centered concept. These five elements are presented below, including a short description of the TFA's support to them.

1. **Integration**. The TFA works with OST programs and maintains continuous contact with the other focus areas in developing and executing science and technology development work supporting tank waste remediation. For the TFA, these programs include Crosscutting, Industry, International, and University programs, the EMSP, applied research program and the ASTD program. For each of these programs, the TFA strives to ensure planned and ongoing science and technology development work supports users' needs effectively, efficiently, and without duplication. (See Section 4.0 for more information on these focus area-centered program components). The TFA facilitates DOE complex

wide integration of technology advances, technical gaps and needs within the topical areas of these programs.

2. **Expanding the Technical Assistance Role**. The TFA seeks to be proactive in solving technical problems, by providing technical assistance to OST and site users. The TFA maintains an extended base of internal and external technical expertise to respond to site needs and evolving requirements. This enables TFA to quickly provide technical assistance, and support the increasing level of requests from user organizations for assistance. TFA's assistance in response to these requests has generally taken the following three forms:

   - Independent reviews such as the review performed for DOE-ID in FY00 to support the selection of preferred technologies for treatment of INEEL's sodium-bearing and calcine wastes and a review for Hanford in FY99 evaluating technical alternatives and risks associated with the Tank Waste Remediation System Phase I privatization;
   - Technical/peer reviews such as, the review of the ORNL dual coriolis deployment and the FIU slurry monitoring test loop; and
   - Special studies/projects such as the technology road-mapping for DOE-ID's baseline.

3. **Maintaining the Highest Technical Capability**. The TFA consists of a network of the most highly qualified federal and contractor technical and program management experts. The TFA's technical core is drawn from seven contractors and national laboratories that regularly contribute to the program (see Appendix A). The TFA's USG, TAG, and independent reviews ensure that the project design and performers work meets the users' needs and is of the highest quality. The TFA uses a performer selection logic to select top quality organizations and principal investigators to carry out the TFA's technical work. The logic assists the TFA in selecting the best organization to perform a task, whether commercial or government, based on qualification, regulatory, schedule, and cost considerations. The performer selection logic also helps the TFA determine whether or not to compete new TFA work scope. In selecting performers via an open or limited competition, the TFA uses selection criteria that complement its performer selection logic, thereby securing the best organization and principal investigator available to perform a task.

4. **User Connection**. The TFA is a consensus-driven program that formally includes users throughout program development and execution. The TFA's annual program cycle includes users throughout the process, including the annual program kickoff activities, technical response development to users' needs, the annual program prioritization meeting, midyear review, and Program Execution Guidance (PEG)/Technical Task Plan (TTP) reviews. Weekly telephone conferences of the TFA's Management Team keep users abreast of key technical and programmatic developments. In addition, TFA coordinates all project activities with the site users and routinely visits each site to brief the users on work performed by others on the sites behalf.

5. **Communication of Science Results**. In communicating science results, the TFA serves at least two roles. In the first, the TFA helps define for EMSP program managers and principal investigators the HLW science needs and how existing science projects can help solve present site science and technology needs. In the second role, the TFA serves as a conduit back to the sites by communicating significant results from ongoing projects. Through the TFA's interactions with EMSP and the various HLW-related projects, the TFA strives to incorporate significant results into its technical

responses and technical approaches that respond to site needs. Successful science results may be continued as applied research projects, which may evolve into technical solutions (data or technology) for site challenges. While the relationship between the TFA and EMSP continues to evolve, significant progress has been made during the past year in synchronizing the activities of both program components.

Section 3.0 Goals and Strategies

The objective of the TFA is to build a risk-driven, fully integrated, fully leveraged science and technology development program that is responsive to user and stakeholder needs to remediate radioactive waste tanks. The program strives to be consistent with DOE's accelerated cleanup plan and enables EM to meet its goals for processing waste (e.g., number of canisters per year) and closing tanks (e.g., number of tanks closed per year).

This section presents the strategic intent of the program through an explanation of the program's goals and strategies, as well as their alignment with EM's major science and technology thrusts.

3.1 Program Goals

The TFA uses three goals to guide program development and execution. These goals are under constant review; however, the present set is a product of the TFA's past and present program and an assessment of future requirements, all developed and coordinated with site users. These goals strive to ensure that TFA invests in science and technology that gets used, that is focused on critical EM problems, and that is balanced between near- and long-term problems. Inherent in these goals is the requirement to deliver the appropriate science and technology results and products to the end user in a timely manner.

Goal #1: Increase use of EM-50-funded results so that 70-90% of products are being used. The key point of the goal is to *increase* the use of EM-50-funded technologies. While the desired percentage of increase may be debated, *increasing* the percentage is most important. By working closely with sites during the annual program development process to ensure user participation and commitment to deploy, this goal also supports EM's major science and technology thrusts of addressing high priority site needs and accelerating deployment of technologies.

Goal #2: Reduce programmatic and technical risk. The TFA seeks to reduce risk for both the user and OST. Essential elements of this goal are the constant pursuit of multi-site technology applications focused on high priority, high risk needs of the users, and the selection of the best technical performers available to most effectively address technical risk issues. Close management of the budget, budget change processes, and site prioritization activities allow the TFA to respond quickly to changes in sites' programmatic risks. This goal supports another EM science and technology thrust to reduce technological risks.

Goal #3: Develop a TFA program portfolio that permits development of contingency or alternative technology approaches in response to site needs. As a proactive science and technology development program, the TFA uses its technical expertise to anticipate problems and risk-reducing technical solutions, even into the outyear planning horizon. Through this goal, the TFA seeks to offer alternative solutions and actively accommodate technological contingencies to the DOE complex. The TFA will continue to work with its user community to define roles and responsibilities for management of the TFA portfolio, especially at key intersections of science and technology development (e.g., between basic science and later technology development stages). In FY01, the TFA will, for the first time, fund tasks termed as "strategic." A key factor in the selection of these tasks is their potential to reduce the costs of storing, treating and disposing of tank wastes, which supports the fourth EM science and technology thrust of

reducing costs. These strategic tasks, encouraged and supported by the TFA's user community, are intended to look beyond the nearer-termed, officially submitted site needs. The TFA will carefully manage these projects to ensure any identified contingency or alternative technology approaches are developed as targets for follow on investment and eventual use.

3.2 Strategies and Tactics

The TFA's strategies and tactics are focused on delivering needed technical solutions (e.g., data and technologies) to accomplish the program goals (above) and meet user expectations. TFA users require a broad range of products and services to address their needs, including providing technical assistance, evaluating and screening technologies, delivering data and technical recommendations, and demonstrating and deploying physical processes (hardware and systems). Each of these products and services requires specific strategies and tactics that embody one or more of TFA's goals.

3.2.1 Technical Assistance

TFA maintains access to an extended base of internal (e.g. TFA Technical Team, Principal Investigators, Crosscutting Programs, TAG) and external technical expertise to respond to site needs and evolving site requirements. This strategy enables the TFA to quickly provide technical assistance to OST and site users. This service is highly valued by site user organizations, as evidenced by the increasing level of requests from user organizations (DOE and contractor) for TFA assistance in conducting independent technical reviews, conducting studies on key issue areas, and in supporting technology roadmapping for current and evolving technical baselines. Several specific examples of important technical assistance provided by TFA include: 1) supporting the identification, evaluation and selection of alternatives for the SRS Salt Processing Project; 2) performing an independent review of the Hanford Tank Waste Remediation System Phase 1 Privatization Project to assess technical alternatives and risks (DOE/EM-0493, September 1999); and 3) performing an independent review and providing recommendations to support the selection of preferred alternatives for treatment of INEEL's sodium-bearing and calcine wastes (PNNL-13268, August 2000).

3.2.2 Technology Evaluation and Screening

Solving the complex range of technical challenges posed by the remediation of HLW tanks requires evaluating multiple technologies and solution paths. Another strategy of the TFA is to assist site users in evaluating and screening candidate processes and technologies to ensure the best solutions are selected for further development and application. TFA looks to industry, national laboratories, universities, international and other EM programs to identify applicable technologies or technical resources. Sharing lessons learned between participating sites through complex-wide workshops and technical exchanges promotes transferring successful solutions between sites and encourages multi-site use of successful technologies. Assisting sites in screening technologies and identifying technical issues or limitations also reduces costs and technical risks. For example, TFA is providing significant support to multiple sites in evaluating candidate melter technologies and developing improvements to existing melters. It is expected that some technology investments will be screened out based on the outcomes of technical evaluations and therefore will not be carried forward to deployment. Therefore, Goal #1 assumes that not all investments will be taken forward to deployment.

3.2.3 Delivering Data and Recommendations

Investing in activities that deliver critical technical data and recommendations to assist users in developing site baselines and making correct decisions is a critical need for TFA site users and another important TFA strategy. In addition to important technology development activities, investing in areas of fundamental science and applied research that may be required to fill critical data gaps is an area of increased emphasis for the TFA. Data and recommendations from these investments, although not deployed in the sense of hardware or processes, are applied by site users in developing, validating, or revising technical baselines and in making key decisions on their program investments to reduce costs and technical risks. Specific examples of accomplishments of the TFA in this area include providing recommendations on operating envelopes for pipeline waste transfers to avoid pipeline plugging, evaluating long-term glass performance to support development of the Hanford ILAW performance assessment, and providing recommendations on improving waste loading in high-level and low-activity glass to decrease the number of waste canisters and the cost for waste disposal.

3.2.4 Deployment

Developing, demonstrating, and deploying technologies (hardware, processes, systems) is a key measure of the TFA's contribution to addressing site needs. TFA's strategy to accelerate technology deployment is to fully engage the site user organizations in collaboratively funding and participating in defining requirements, selecting technologies, evaluating the results of testing and demonstrations, and in the planning and execution of technology deployments. Additional tactics used to promote successful deployment of technologies include: executing agreements with site user organizations (e.g. Memorandum of Agreement) that clearly define mutual expectations and delineate roles and responsibilities; developing integrated project plans and schedules for both user- and TFA-funded workscope; working with DOE site representatives to incentivize contractors to deploy technologies (e.g. performance based initiatives (PBIs), stretch fee goals); increasing expectations for user-funded, up-front investment in requirements definition, development and testing, and deployment planning; gaining an understanding of the user's regulatory, safety, and operational drivers early in the development process; and proactively tracking performance on milestones and deliverables, with special emphasis on key deliverables for critical projects. Examples of projects where these tactics have resulted in successful deployments include the Light-Duty Utility Arm deployments at ORNL and INEEL, deployment of AEA Technology's fluidic mixing technologies at ORNL and SRS, and deployment of Flygt Mixer technology at ORNL and SRS.

3.2.5 Communications

Communicating successes and lessons learned has been a successful tactic in promoting multi-site use of technologies. The TFA uses a number of tools and methods to keep users across the complex aware of applicable activities at other sites. The TFA actively works with DOE and contractor representatives at user sites to maintain a current awareness of requirements and evolving baselines to allow prompt response to changes and to ensure ongoing TFA projects maintain alignment with site technical baselines. This is important to ensure multi-year development efforts maintain focus and will meet current requirements when ready for deployment. TFA's online records database, called the Tanks Technology Guide (http://www.pnl.gov/tfa/program/index.stm), houses a large compendium of documents and information related to tank waste remediation that is readily available to support users, developers, and

producers. TFA also maintains a comprehensive website that is updated regularly with the latest technical and programmatic developments.

3.2.6 Overcoming Obstacles

A number of barriers inherent to a program of this scope must be continually addressed to ensure successful delivery of technical solutions. Some of these issues include working with site management (DOE and contractor) to ensure availability of site personnel to actively participate in TFA-funded projects from initial requirements definition through to deployment (developing ownership); differing site practices and requirements for product acceptance, safety bases, and operational assessments (challenges to multi-site application of technologies); interfacing with multiple site organizational interfaces having differing perspectives and priorities (identifying the "real" user and decision makers); overcoming ingrained preferences ("not-invented-here" mentality); and integrating planning and funding profiles between different EM offices to accomplish a common objective (aligning priorities). These are all areas where the TFA works closely with site users and employs a process of self-assessment and application of lessons learned to overcome issues and barriers to achieve successful deployments.

Section 4.0 Focus Area-Centered Program Components

In developing and maintaining its investment portfolio and operating in its focus area-centered approach, the TFA integrates science and technology from the following OST programs.

- CMST Crosscutting Program
- ESP Crosscutting Program
- RBX Crosscutting Program
- Industry Programs
- University Programs
- International Programs
- ASTD Program
- EM Science Program
- Other focus areas

For each of these programs, the TFA strives, through its integration role, to ensure planned and ongoing science and technology development work supports users' needs effectively, efficiently, safely, and without duplication. The primary reason the TFA invests in science and technology development activities is to reduce the risks associated with tank waste remediation. Risks include environmental, safety, and health risks to workers and the public; ecological risks; cost and schedule risks; programmatic risks; and technical risks. The strategic intent of the TFA is to work closely with the tank site user programs and the STCGs to develop a risk-based prioritization of technical responses to site needs and invest wisely in those responses. (Refer to Figure 1.1, Tanks Focus Area Organization.)

The TFA's strategic intent is to leverage every available investment in science and technology made by DOE and, in doing so, engage the entire intellectual capacity of the nation in addressing the HLW problem area. In the model illustrated in Figure 4.1, each element in the technology maturation cycle 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. Deployment plans and memorandums of understanding formalize the commitment between TFA and its user, producer, and developer partnerships across sites, establish milestones and results that must be obtained to meet multi-site requirements and ensure technology implementation.

The TFA continues to be responsible for the scope, schedule, and budget of OST's HLW tank remediation program described in this MYPP. The TFA coordinates tank waste-related work conducted by OST crosscutting programs, ASTD, EMSP, International, Industry, and University Programs, as well as related work conducted by other focus areas and by each of the site's Site Closure or Project Completion programs. While site-specific technology continues to be managed by each site,

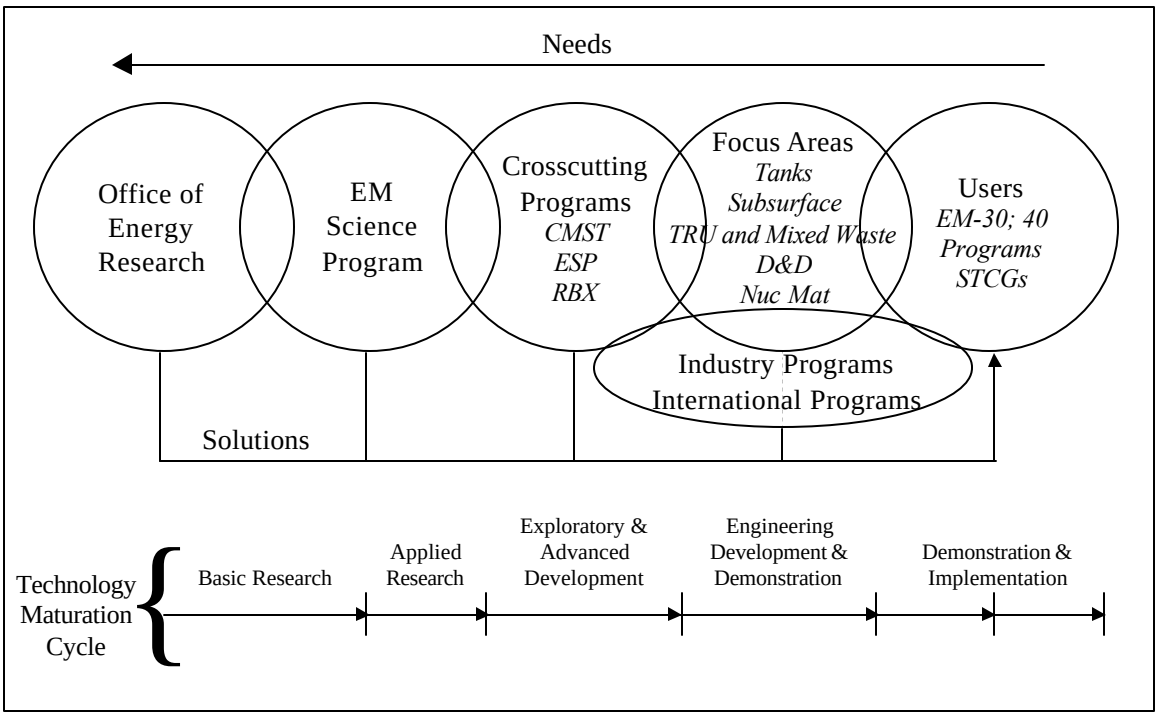

Figure 4.1. Tanks Focus Area Conceptual Strategy Model

the TFA is cognizant of all tank technology activities within EM to provide technical assistance across sites, support site negotiations, and manage technical uncertainties with practical technical expertise. Additionally, the TFA remains cognizant of the activities in the other focus areas (Subsurface Contaminants; TRU and Mixed Waste; Nuclear Materials and Deactivation and Decommissioning) and leverages, where applicable, other focus area activity to provide solutions to HLW science and technology needs.

4.1 Crosscutting Programs

The TFA actively engages and coordinates the efforts of OST's crosscutting programs—ESP, CMST, and RBX. The TFA is the customer for HLW technologies developed in these programs and facilitates these technologies' transition through the EM stage-gate framework from development to implementation. As such, the TFA requests support in areas consistent with its priority tasks (see Appendix B) and actively works with these programs to review and transfer these technologies. This "focus area-centered" approach requires routine interaction and an increased level of cooperation between the TFA and the crosscutting programs.

In FY00, the TFA initiated agreements of cooperation with the crosscutting programs. Development of these agreements caused both the TFA and the crosscutting programs to give serious consideration to all issues affected by the implementation of the focus area-centered concept. The main subject areas of the agreements include:

- Technical response development
- Performer selection bases
- PEG and TTP preparation
- Program execution
- Communication products.

The TFA will continue to work with the crosscutting programs to ensure working relationships remain practical in support of users managing HLW throughout the DOE complex.

Technical experts in each crosscutting program are assigned to interface with the cognizant TIM within TFA. Annual meetings, technical seminars, workshops, joint technical response development, and administrative planning are some of the means by which the integration is accomplished.

Examples of FY01 cooperation include:

- ESP's leadership in developing and executing two TFA strategic tasks, Selective Chemical Dissolution of Tank Heels to Improve Retrieval, and Removal of Key Non-Radioactive Elements from Tank Waste (see Section 5, Problem Elements 1.2.1.2 and 1.2.2.7), and a major technology development project on Sludge Washing and Dissolution (see Section 6, Problem Element 1.2.2.7). The TFA and ESP will also collaborate in developing applied research projects most applicable to HLW remediation.
- CMST's participation with the TFA in satisfying SRS's need to monitor weight percent suspended solids during the mobilization and transfer of sludge from HLLW storage tanks (see Section 5, Problem Element 1.1.3). The TFA and CMST will also collaborate in developing applied research projects most applicable to HLW remediation.
- RBX's development of remote technologies to enhance tank integrity inspections (see Section 5, Problem Element 1.1.1.1).

4.2 Industry Program

Industry's contribution to the 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 entities, including industry, management and integration (M&I) contractors, management and operations (M&O) contractors, national laboratories, or universities with a DOE grant. Internal partnering occurs 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, and national laboratories with environmental research and development programs that are recognized and supported by DOE.

Direct external contracts between TFA and industry are secured through a specific site procurement office (DOE or contractor) or through the DOE National Energy Technology Laboratory (NETL) procurement office. The TFA does not directly request industry proposals nor does it accept unsolicited proposals. Rather, industrial partners are encouraged to communicate through NETL on all proposals, solicited or unsolicited. Responses or inquiries to requests for proposals (RFPs) solicited through an operating 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 DOE Acquisition Regulations and use prescribed contractual procedures, which vary from site to site. Therefore, industry partners are encouraged to become familiar with the relevant site requirements before responding to RFPs.

4.3 International Program

The TFA's strategic intent for the International Program is to leverage opportunities and coordinate DOE's foreign investments in technology, performance data, and resources that relate to tank waste remediation needs. 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. The TFA requests support in areas consistent with its priority tasks (see Appendix B) and actively works with International Programs to review and transfer these technologies.

On behalf of the TFA, the International Program is supporting Russian involvement in the development of a single-step process for removal of TRU, Sr, and Cs at INEEL (see Section 5, Problem Element 1.2.2.5), advanced chemical cleaning methods for retrieval of tank heels and sludges, and evaluating the U.S. application of an innovative melter technology concept, the cold crucible melter. In a parallel effort, the International Program is negotiating with France to conduct similar cold crucible melter research. Additionally, the International Program supports the TFA's work with AEA Technology (AEAT), a Great Britain-based commercial firm. In FY01, the TFA will engage AEAT in technology development activities involving waste sampling, LAW immobilization, and tank waste chemistry. Finally, the TFA is continuing its immobilization support to Argentina in FY01.

4.4 University Program

One means of identifying and fostering science and technology development is the nation's universities. The TFA's strategy for working with universities is to leverage resources available through the University Program managed by NETL. Specifically, the TFA works with those universities that have environmental research and development programs that are recognized by and supported by DOE in advancing science, technology development, and industrial relationships.

Several good examples of University Program support to the TFA include:

- Mississippi State University's Diagnostic Instrumentation & Analysis Laboratory (DIAL) involvement in evaluating saltcake dissolution and concentrate re-precipitation phenomena (see Section 5, Problem Element 1.2.2.3), and sludge processing modeling (see Section 5, Problem Element 1.2.2.7).
- Florida International University's (FIU) involvement in developing and demonstrating melter pour spout design improvements (see Section 5, Problem Element 1.2.3.2) and waste transfer line plugging prevention and unplugging methods (see Section 5, Problem Element 1.2.1.4).

In FY01, the TFA will engage both DIAL and FIU in several strategic projects. These projects center mainly on waste characterization and process monitoring.

4.5 EM Science Program

Integrating science with the TFA's technology development efforts is critical to the success of both TFA and EMSP. Acceleration of the technology development cycle through the integration of science can be achieved by maintaining multidisciplinary teams that will deliver timely solutions to both short- and long-term environmental problems faced by DOE. The strategic intent of the TFA is to support strong programmatic and technical links between the EMSP, problem holders, and other EM programs.

The success of the EMSP depends on the utility and application of its results. The science program must have mechanisms through which new information and discoveries can be communicated to the users, so that this new information can be used to impact clean-up actions. The TFA will use numerous methods to foster communication such as annual workshops, special TFA seminars, and technical society symposia. Additionally, technical highlights and reports generated by TFA will be distributed to the relevant EMSP principal investigators.

The TFA intends to continue strengthening its integration with EMSP, building on the closer relationship forged in FY00. The TFA has been involved in technical relevancy reviews, and continues to closely monitor EMSP projects identified for renewal or continuance. The TFA has begun to transition promising EMSP scientific work into more advanced stages in the science/technology development continuum. The TFA will transition some work that will not continue under EMSP into an Applied Research program administered through NETL, and will continue incorporating EMSP advances into the core program managed directly by the TFA. Descriptions of the TFA's key interest areas are located in several problem elements within Section 5.2. A listing of tanks-related EMSP projects is found within Appendix F.

4.6 Accelerated Site Technology Deployment Program

The ASTD Program is chartered with accelerating the implementation of previously demonstrated technologies or processes in EM clean-up activities. Accomplishing this mission requires DOE complex-wide cooperation and coordination in identifying, verifying, implementing, and subsequently deploying the technologies. In FY99, ASTD was more fully incorporated into the focus areas, which act as facilitators and integrators for ASTD projects. The TFA provides project coordination among all project

participants, keeping its sponsors, customers, and stakeholders aware of project progress and issues, and the potential for application at other sites.

In FY01, the TFA will complete two ASTD projects at ORR: Gunite and Associated Tanks (GAAT) Remediation and the Wastewater Triad Project.

Section 5.0 Technical Program

5.1 Technical Program Summary

This section provides an overview of the technical program, including a brief discussion of assumptions and recommendations for a national science and technology program. In addition, this section summarizes TFA's technical strategies, planned accomplishments, and recommended program budget for addressing priority science and technology needs.

5.1.1 Program Overview

The TFA has continuously improved its program planning and development process since its inception in FY95, striving to meet and exceed the goals and strategies outlined in Section 4. In FY95, the TFA developed the organizational and technical basis for a nationally integrated science and technology program. During FY96, the TFA more fully developed an understanding of DOE complex-wide tank remediation issues. In FY97, the TFA established closer relationships with site users to improve the quality of the technical responses to site needs and to involve the users in program prioritization. This resulted in submission of a consensus-based FY99 Internal Review Budget and construction of a multiyear program plan and final FY98 program that was endorsed by the HLW Steering Committee (consisting of the sites' assistant managers [AMs]) and approved by the appropriate Deputy Assistant Secretaries for EM. In FY98, TFA further refined the process to 1) ensure technical responses to site needs met user requirements and were prioritized with the users, 2) ensure the program definition integrated all TFA activities and resources including the core program, crosscutting programs, Industry Program, International Program, University Program, and ASTD into a single, focus area-centered program to respond to the highest priority tank waste remediation needs, and 3) confirm user commitment to use the results of science and technology investments to meet their needs. In FY99 and FY00, TFA began incorporating the results of applicable EMSP projects and including the EMSP principal investigators in the program planning and development process. In FY00, strategic and applied research tasks were incorporated into the TFA portfolio leading to the FY02 OST CRB and the FY01 science and technology program outlined here.

This document represents the cumulative and fully integrated science and technology program required to meet the priority needs of the tank waste remediation system at the five DOE tank sites. Successful integration of all science and technology resources remains a challenge, and the TFA will continue to emphasize integration as the key element of the Focus Area-centered concept. Constantly changing budget priorities and site needs demand constant and significant management and technical attention. With the force of the entire TFA team behind efforts to implement the Focus Area-centered program, the next program development cycle should yield an even more responsive program for all EM tank remediation investments.

5.1.2 Technical Program Structure

The generic process flowsheet for tank waste remediation is depicted in Figure 5.1. Each step in the process is further defined using a problem element structure (listed below each process step in Figure 5.1

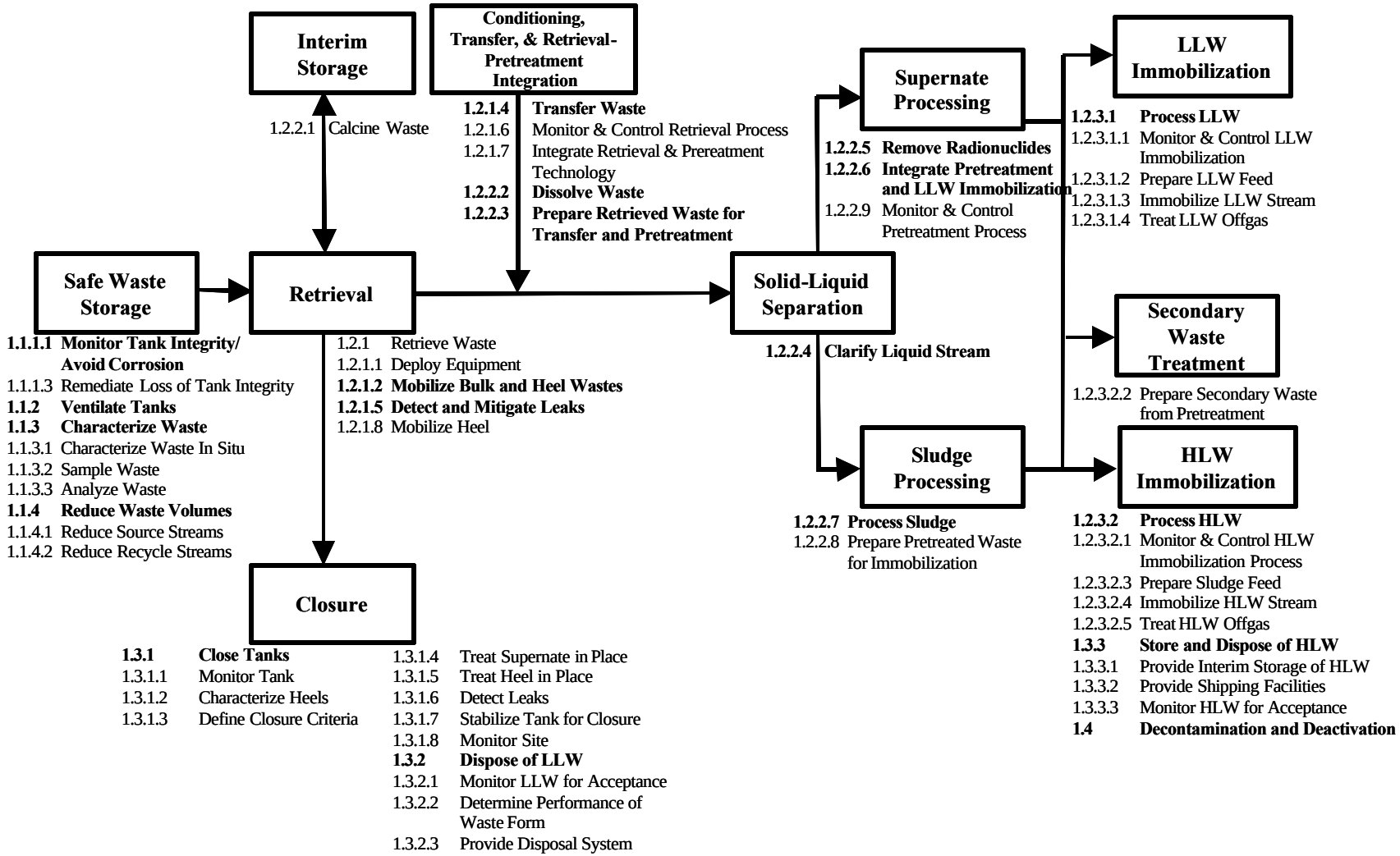

Figure 5.1. Generic Tank Remediation Flowsheet (Problem Elements in bold indicate TFA has developed technical responses for site needs)

which identifies discrete technical requirements and activities within the generic flowsheet. Tank waste remediation science and technology needs received from the sites are categorized within this structure. This structure provides a compact, understandable, process- and systems-oriented foundation for managing program development and execution. The FY00 Site Needs Assessment (TFA 2000)[(a)] resulted in technical responses to each site need that were organized within the problem element structure (see http://www.pnl.gov/tfa/program/needs00/index.stm). These needs provided the basis for the multiyear program described in this document. The problem elements shown in bold in Figure 5.1 are those for which site needs were received and for which TFA has developed technical responses and corresponding budgets in FY01 and beyond.

5.1.3 Technical Strategies and Investments

This section summarizes the technical basis and strategies for FY01 and beyond for each process step and corresponding problem element depicted in Figure 5.1. More detailed descriptions of the technical needs, strategies, and technical activities are provided in Section 5.2. Table 5.1 provides a summary of the budget requirements to address top priority needs for FY01 and FY02, and all priority needs for FY03 and beyond. The required budget for the technical workscope is $40.7M and $54.1M for FY01 and FY02, respectively. The FY03-FY05 budget requirements assume unconstrained funding levels but are

Table 5.1. Budget Requirements of Problem Elements

Problem Element #	Problem Element Title	FY01	FY02	FY03	FY04	FY05	Total
1.1.1.1	Monitor Tank Integrity/Avoid Corrosion	3440	4955	4400	4200	4200	21195
1.1.2	Ventilate Tanks	405	170	475	400	400	1850
1.1.3	Characterize Waste	2350	4060	3500	3000	3000	15910
1.1.4	Reduce Waste Volume	800	1750	2000	2000	2000	8550
1.2.1.2	Mobilize Bulk and Heel Wastes	6135	10475	9225	8000	7000	40835
1.2.1.4	Transfer Waste	2450	2100	4950	4500	4500	18500
1.2.1.5	Detect and Mitigate Leaks	500	1000	1500	1750	2000	6750
1.2.2.3	Prepare Retrieved Waste for Transfer and Pretreatment	3275	3525	3250	3200	3200	16450
1.2.2.4	Clarify Liquid Stream	300	250	800	850	850	3050
1.2.2.5	Remove Radionuclides	8120	8800	6250	6000	6000	35170
1.2.2.6	Integrate Pretreatment and LLW Immobilization Technology Systems	540	420	720	500	500	2680
1.2.2.7	Process Sludge	1925	2410	3200	3300	3300	14135
1.2.3.1	Process LLW	1330	850	1250	1300	1300	6030
1.2.3.2	Process HLW	5475	3715	4100	4900	4800	22990
1.3.1	Close Tanks	550	1150	3500	4500	4500	14200
1.3.2	Dispose of LLW	1000	1370	2500	3000	3500	11370
1.4	Decontamination and Decommissioning	2095	7105	5000	4550	4500	23250
Grand Total		40690	54105	56620	55950	55550	262915

(a) Tanks Focus Area. 2000. *Tanks Focus Area Site Needs Assessment FY 2000.* PNNL-13186, Pacific Northwest National Laboratory, Richland, Washington.

based on FY00 site need submittals. As the outyears approach, TFA anticipates that new issues and problems will give rise to additional, high-priority site needs that cannot be predicted at this time. Therefore, work activities planned for FY02 and beyond may be delayed or rescoped depending on the actual budget level authorized and changing needs and priorities of the sites. Although the TFA 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 program management activities and the budgets associated with them are not included in this document. These activities include technical strategy development, technology delivery, and overall program management.

5.1.3.1 Safe Waste Storage

Investments in safe waste storage are needed to fill technical gaps, reduce costs, and avoid costly problems while ensuring protection of the public and environment. Priority site needs are focused on science and technology to 1) improve tank integrity monitoring and corrosion prevention, 2) improve tank ventilation, 3) improve waste characterization, and 4) reduce the volume of waste entering the tank farm through source and recycle stream waste reduction.

Problem Element 1.1.1 is to "Extend Tank Life." The TFA's approach for avoiding tank corrosion is to pursue two technical solutions. One solution is to improve upon methods for maintaining tank waste chemistry within site specifications by adapting commercial monitors for in-tank analysis of inhibitors and major species that control corrosion rate. The second solution for avoiding tank corrosion 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. The strategy for evaluating tank integrity includes near- and longer-term approaches. Commercial nondestructive examination techniques will be evaluated and modified to support near-term deployments of an arm-based or crawler-based system to inspect tank walls. Longer-term efforts will integrate needs from multiple sites to define, develop, and test the specific systems needed to inspect tank floors, inspect surfaces below the liquid level, and assess a tank's integrity before reuse or waste retrieval. Specific technologies supported by the TFA to replace the baseline techniques include:

- Develop an electrochemical noise corrosion monitor, deployed through a tank riser, for use at SRS and Hanford.
- Develop a Raman-based nitrate, nitrite, and hydroxide ($NO_2^-/NO_3^-/OH^-$) in-tank sensor for corrosion inhibitor concentration monitoring at SRS.
- Develop remotely operated NDE methods for determining integrity of waste tanks, including end effectors to be deployed by a robotic arm or crawler-based platform.
- Develop a small roving inspection vehicle for inspection of tank annuli.
- Develop remotely operated destructive evaluation and repair system.
- Demonstrate transfer piping photographic system.
- Select and demonstrate commerical camera systems for inspection of tanks.

The TFA is also making a strategic investment in FY01 to develop a methodology for evaluation of stable, interim waste tank configurations for the time period after waste retrieval activities have been completed but before final tank closure.

Problem Element 1.1.2 is titled "Ventilate Tanks." The TFA's goal regarding this problem element is to reduce the cost of active ventilation. Specific activities include:

- Select and demonstrate regenerable filter systems to replace HEPA filters within the existing active ventilation system. A commercial system will be procured for demonstration.
- Select and demonstrate commercial alternative filtration technology for calcine transfer applications.

Problem Element 1.1.3 is titled "Characterize Waste." The TFA's goal regarding this problem element is to invest in tools and methods to characterize waste in situ to support sludge and supernate processing at Hanford, SRS, and ORR. Specifically, the TFA will:

- Develop and deploy a fluidic sampler into a Hanford waste tank to support feed staging for waste processing.
- Develop the LDUA sampling end effector for sludge/liquid sampling at INEEL.
- Develop a dual coriolis weight percent solids monitor to support pipeline transfers and tank mixing.
- Adapt a small-diameter steerable tool called an endescope for sampling tanks and vessels through 1- to 2-inch diameter process lines.
- Evaluate technologies for tank sludge and obstacle mapping.
- Develop methods for in-situ waste characterization.
- Optimize and upgrade laser ablation/mass spectrometry (LA/MS) equipment and procedures for quantitative elemental analysis of solid samples.
- Conduct round robin tests on Technetium-99 (Tc-99) analytical procedures to reach consensus on preferred methodologies for Tc-99 analysis in tank wastes.

The EMSP has funded several projects that are relevant to waste characterization. The TFA anticipates funding applied research studies in the general area of waste characterization and process monitoring.

Problem Element 1.1.4 is titled "Reduce Waste Volumes." The TFA's goal regarding this problem element is to implement technologies to reduce source and recycle streams at SRS and INEEL. Specifically, the TFA will:

- Evaluate waste chemistry, materials corrosion, and process considerations associated with evaporation as an approach to reducing recycle from DWPF back to SRS tank farms.
- Identify and evaluate methods for removing mercury and chlorides from INEEL waste streams such that they can be treated and disposed through less costly methods.
- Identify and evaluate opportunities for reducing waste generation from INEEL's decontamination facility, analytical laboratories, and filter leach facility.

For more information on these problem elements, see Section 5.2.

5.1.3.2 Waste Mobilization and Retrieval

Investments in waste mobilization and retrieval fill technical gaps and reduce costs while ensuring safe operations. Priority site needs are focused on science and technology to 1) mobilize and retrieve bulk and heel wastes, including sludge and saltcake, and 2) detect and mitigate leaks during retrieval.

Problem Element 1.2.1.2 is titled "Mobilize Bulk and Heel Waste." The TFA's goals regarding this problem are to provide the following technologies and technical solutions:

- Advanced design mixer pumps for waste mixing and retrieval.
- Low-volume density gradient techniques coupled with low flow rate pumps for bulk saltcake dissolution and removal without mixer pumps at Hanford and SRS.
- Enhanced sluicing systems, including enhanced nozzle and sweep designs for Hanford.
- Russian Pulsating Mixer Pump technology for slurry mobilization and transfer.
- Sludge mobilization and retrieval techniques for sludge heel retrieval at SRS and Hanford.
- Improved operation of baseline mixers at SRS.
- Flygt Mixers for waste mixing and mobilization to enhance bulk waste retrieval at SRS and Hanford.
- Chemical methods for heel removal and tank cleaning.
- Crawler based systems for heel removal from unobstructed tanks.
- Commercial technologies for retrieving INEEL calcines from storage bins.
- Heel retrieval systems for tanks with internal obstructions.

Problem Element 1.2.1.5 is titled "Detect and Mitigate Leaks." The TFA's goals relating to this problem are to provide leak detection devices that can rapidly output data to guide retrieval operations, and create strategies to mitigate leaks detected during retrieval. To address this goal, the TFA will:

- Identify and evaluate leak detection systems.
- Identify and evaluate leak mitigation and repair systems.

In addition, the TFA is making strategic investments in FY01 to 1) improve retrieval processes by chemical adjustments to dissolve some components, breakup agglomerates, or other mechanisms that reduce solids particle sizes; and 2) evaluate methods for retrieving wastes from potentially leaking tanks.

For more information on these problem elements, see Section 5.2.

5.1.3.3 Conditioning, Transfer, and Retrieval-Pretreatment Integration

Retrieved wastes need to be transferred, and may require monitoring and physical and/or chemical conditioning to avoid problems with re-precipitation, solids formation, plugging of transfer lines, and settling, or simply to enhance downstream processing. Investments are needed for data and technologies to ensure the interface between retrieval and pretreatment avoids unwanted problems.

Problem Element 1.2.1.4 is titled "Transfer Waste." The TFA's objectives relating to this problem are to provide the technologies to facilitate transferring wastes among tanks and to waste treatment facilities. To meet these objectives, the TFA will

- Develop improved variable-depth transfer pump to optimize waste retrieval from SRS and Hanford tanks.
- Demonstrate tools for locating blockages in transfer piping.
- Identify chemical and physical parameters that influence pipeline plugging.
- Demonstrate technologies for removing blockages and plugs from transfer pipelines.
- Develop a temporary, above-ground, disposable transfer line for applications where pipelines are nonexistent or are plugged.

Problem Element 1.2.2.3 is to "Prepare Retrieved Waste for Transfer and Pretreatment." The TFA's goal regarding this problem is to ensure retrieved wastes are ready for downstream processing. Specific activities include:

- Evaluate chemistry of waste streams at Hanford and Savannah River in order to understand and prevent conditions leading to solids formation during waste retrieval, blending, transfers, and treatment.
- Determine dissolution kinetics and partitioning during saltcake dissolution to support saltcake retrieval at Hanford.
- Update kinetic and thermodynamic models to facilitate planning for waste retrieval, blending, and transfers.

The EMSP has funded several projects that are relevant to waste chemistry and solids formation. The TFA anticipates funding applied research studies in the general area of waste chemistry.

For more information on these problem elements, see Section 5.2.

5.1.3.4 Interim Storage

Interim storage includes those activities to enable storage of wastes as dry materials. Efforts are focused on calcination and dissolution of INEEL wastes.

Problem Element 1.2.2.2 is titled "Dissolve Waste." The TFA's goals are to provide data and technology to enable waste processing at INEEL. Specific activities include:

- Evaluate the chemistry and dissolution behavior of existing calcine and bench-test preferred dissolution schemes to support flowsheet design decisions.

For more information on these problem elements, see Section 5.2.

5.1.3.5 Waste Pretreatment

Investments in waste pretreatment must be fully integrated with waste retrieval, which provides feed to pretreatment, and waste immobilization, which receives feed from pretreatment processes. The

pretreatment step is critical to reducing the volume of LLW and HLW products, leading to reduced disposal costs. Investments include clarifying liquid streams through solid-liquid separations, supernate processing to remove radionuclides, and sludge processing to remove excess chemical species that either increase the volume of HLW or adversely impact the performance of the HLW form. On Figure 6.1, pretreatment is shown as these three investments.

Problem Element 1.2.2.4 is titled "Clarify Liquid Streams." The TFA's goal regarding this activity is to deliver data and technologies to meet ORR, SRS, Hanford, and INEEL needs for process selection. Specific activities include:

- Evaluate solid/liquid separations technologies including cross-flow filtration to define operation conditons and performance limitations for application at INEEL.

Problem Element 1.2.2.5 is titled "Remove Radionuclides." This includes reducing the levels of Cs, Tc, Sr, or TRU to meet LLW disposal requirements onsite. The TFA's goal regarding radionuclide removal for alkaline wastes is to deliver improved Cs separations systems to reduce cost and technical risk at INEEL and SRS. Specific activities include:

- Provide the necessary data to support SRS's evaluation of crystalline silicotitanate ion exchange, caustic side solvent extraction, and small-tank tetraphenylborate processes for Cs removal and to support design and implementation of the selected process.
- Evaluate alternatives and provide design data for Sr & TRU removal processes at SRS.

In addition, the TFA is supporting the EM-40 led Technical Working Group by providing direct oversight and management of the research and development activities related to the SRS Salt Processing Project.

The TFA's goal for TRU, Cs, and Sr removal from acidic wastes is to provide performance and engineering data to INEEL users on solvent-extraction and ion-exchange processes to confirm process assumptions, support a NEPA Record of Decision (ROD), and support Title 1 design. The TFA's goals are:

- Demonstrate TRU and Sr solvent-extraction processes at INTEC with actual wastes.
- Develop an integrated Cs solvent-extraction process through the ESP Crosscutting Program for consideration as part of the INEEL flowsheet.
- Test alternative Cs and Sr separations processes through the ESP Crosscutting Program to provide additional performance data to support flowsheet development and downselects.

Problem Element 1.2.2.7 is titled "Process Sludge." The TFA's goal relating to this work is to provide Hanford, SRS and Oak Ridge with baseline processing data support. Specific activities include:

- Determine optimum process conditions for enhanced sludge washing for Phase II at Hanford.
- Determine optimum process conditions for processing Savannah River waste sludges.
- Determine appropriate treatment technique for Oak Ridge HFIR, T1, and T2 tank sludges/resins.

The TFA is making a strategic investment to evaluate methods for removing chemicals such as chromium, phosphate, sulfate, and mercury from the waste that can have negative impacts on downstream processing and vitrification. The EMSP has funded several projects that are relevant to sludge processing. The TFA anticipates funding applied research studies in the general area of waste chemistry.

For more information on these problem elements, see Section 5.2.

5.1.3.6 Waste Immobilization

Waste immobilization includes LLW immobilization, secondary waste treatment, and HLW immobilization. Efforts are focused on reducing cost and enhancing the baseline at SRS, as well as filling technical gaps in the baseline for Hanford and INEEL.

Problem Element 1.2.3.1 is titled "Process LLW." The TFA's goals regarding immobilizing LLW are to establish baseline processes for INEEL LAW immobilization and support Hanford and ORR LLW treatment plans. Specific activities include:

- Develop grout formulations for INEEL's LAW.
- Evaluate alternative sorbents and stabilizers to improve the performance of waste forms for radioactive and hazardous wastes.

Problem Element 1.2.3.2 is titled "Process HLW." The TFA's goals regarding HLW processing are to reduce costs of HLW processes at SRS and to reduce the technical risks of HLW processing at INEEL and Hanford through process definition. Specific activities relating to this goal include:

- 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 Cr, Tc, phosphate, halides, and actinides to optimize waste loading of these components.
- 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 improved melter pour spout (Florida International University and Clemson University) and improved melter designs to accommodate noble metals deposits.
- Evaluate melter feed chemistry enhancements to optimize glass melting process.

The TFA is making a strategic investment in FY01 to evaluate the induction-heated, cold crucible melter technology for waste streams that may benefit from higher melting temperatures for waste vitrification.

Problem Element 1.3.2 is titled "Dispose of LLW." The TFA's goal for FY01 and beyond regarding LLW disposal is to ensure the availability of that data to support design of LLW disposal systems. Specific activities include:

- Integrate efforts with the Hanford Vadose Zone/Groundwater project.
- Integrate with LLW disposal efforts.

- Integrate with ongoing and past science and technology investments (including Subsurface Contaminants Focus Area and EMSP) to define and prioritize specific technical issues to be addressed for improved performance assessment and design data including barrier systems to support Hanford.
- Provide technical data relating to glass composition and waste form durability to support product acceptance and performance assessment analyses.
- Determine the extent and impact of glass cracking in LLW glass packages for disposal.

Problem Element 1.3.3 is titled "Store and Dispose HLW." The TFA's goals for FY00 and beyond regarding storage and disposal of HLW are to ensure the availability of methods and data to support the disposition of secondary wastes from HLW processing and to store and transfer HLW. Specific activities iclude:

- Identify, demonstrate, and qualify alternative canister decontamination methods for application at WVDP and SRS.

Problem Element 1.4 is titled "Decontamination and Deactivation." The TFA's goals for this problem element focus on providing the remote tools necessary to operate efficiently in a radioactive environment, for maintenance, and for removal, size-reduction, and sorting of failed processing equipment. Specific activities include:

- Provide remote technology to enhance cleaning, decontamination, and reconfiguration of Hanford jumper pits and SRS CTS pit.
- Demonstrate techniques for segregating/removing glass from failed melters.
- Demonstrate disassembly, decontamination, and size-reduction of ancillary canyon equipment.
- Provide remote technology to decontaminate and package long-length HLW tank equipment.
- Provide remote equipment for maintenance activities in process cells.

For more information on these problem elements, see Section 5.2.

5.1.3.7 Closure

Tank closure activities include sampling or characterization of tank residuals, defining the closure criteria (i.e., answering the question "how clean is clean?"), and stabilizing the tank for closure.

Problem Element 1.3.1 is titled "Close Tanks." Investments in tank closure include advancements in grout formulations and delivery methods to improve performance for immobilizing residual tank waste and stabilizing SRS and ORR tanks. In addition, all aspects of tank isolation and stabilization for ORR and establishment of a basis for closure at Hanford and INEEL are required to reduce mortgages and move forward with retrieval and final tank closure decisions. The TFA's goal regarding tank closure is to deliver the technologies and data to enable all five tank sites to proceed toward closure. Specific activities relating to this goal include:

- Define tank closure acceptance criteria and technical bases for INEEL tanks.
- Develop and demonstrate grouting technology for tank closure.

- Develop an improved understanding of Tc chemistry in tank heels and evaluate methods to remove Tc because of its significant contribution to dose in tank closure risk assessments.
- Evaluate technologies for sequestering radionuclide migration from tank closure and LLW disposal facilities.

  For more information on these problem elements, see Section 5.2.

5.2 TFA Problem Elements

The TFA problem elements are described on the following pages. Together, these problem elements form the core of the TFA program as depicted in Figure 5.1. Each problem element description includes the following sections. Title, Problem Element Description and Priority Site Needs, and Technical Tasks. The Problem Element Description and Priority Site Needs section includes a table with the site need number, the title of the need as submitted by the site, the PBS number for each need, the title of the technical task addressing the need, and the OST technology number. (An index of OST technologies cited in this section is provided in Table 5.2.) In several instances, a need statement submitted by a site may include several needs that are addressed in several problem elements. Each technical task description includes a title, references to the technical response and work package, a brief summary of the need being addressed, and a list of key activities and schedule to resolve the need. For those activities funded in FY01, Budget Profiles are provided that show the associated TTP numbers and budgets. In a few instances, it was not possible to clearly identify the funding split when a particular TTP task spanned two or more problem elements. In addition, University Programs are funded through the National Energy Technology Laboratory (NETL). All funding totals are shown as $ x 1,000.

Figures 5.2 through 5.6 show the path to closure for the Hanford, INEEL, ORR, SRS, and WVDP. For each site, key TFA activities supporting the path to closure are identified.

Appendix B provides the STCG Needs/Prioritized Multiyear Response table and the Site Technology Crosswalk table.

Table 5.2. Index of TFA OST Technologies

Cost #	Technology Title
10	Alternative Landfill Cover (SCFA)
20	Out of Tank Evaporator
21	Cesium Removal Using Crystalline Silicotitanate
22	SRS Tank Closure
82	Low Activity Waste Forms
85	Light Duty Utility Arm
127	Laser Ablation/Mass Spectroscopy (LA/MS)
130	Topographical Mapping System (TMS)/Laser Range Finder (LRF)
233	Sludge Washing
279	Automated Monitoring System for Fluid Level and Density in High-Level Waste Tanks (CMST)
347	TRUEX/SREX
350	Crossflow Filtration
410	Cobalt Dicarbollide Development (U.S.) (ESP)
523	Barriers and Post-Closing Monitoring (SCFA)
810	LDUA - Supervisory Data Acquisition and Supervisory Control System
812	Confined Sluicing End Effector
841	Russian Separations - Cobalt Dicarbollide (ESP)
860	Grab Sampler End-Effector
881	Calcine Dissolution
890	Stereo Viewing Systems
1510	Pulsed-Air Mixer
1511	AEA Fluidic Pulse Jet Mixer
1547	Comparative Testing of Pipeline Slurry Monitors (CMST)
1985	Corrosion Probe
1989	Saltcake Dissolution
1996	Non-destructive Examination End-Effector
2009	High Activity Waste Forms and Processes
2011	In-Tank Waste Retrieval - Arm Based System
2012	In-Tank Waste Retrieval - Vehicle Based System
2015	Integrated Raman pOH Sensor for In-Tank Corrosion Monitoring (CMST)
2087	Remote Maintenance Design for Tank Waste Compact Processing Units (Robotics)
2091	Metal Filters for Waste Tank Ventilation
2092	DWPF Melter Pouring Enhancements
2094	Product Acceptance Testing
2096	Pretreatment Process Analysis Tool
2097	Heel Retrieval for SRS
2115	Retrieval Analysis Tool
2117	Enhanced Sluicing
2118	Vadose Zone Characterization System
2119	Nested Fixed Depth Fluidic Sampler
2181	Equipment Pit D&D System (Robotics)
2195	Tank Riser Pit Decontamination System (Robotics)
2232	Flygt Mixer
2235	At-Tank Sampling for High-Level Waste (CMST)
2236	Sludge Wash Monitor (CMST)
2366	Disposable Crawler
2367	Pipe Unplugging
2368	Multipoint Grout Injection
2370	Russian Retrieval Technologies
2371	Thermal Denitration
2383	Vitrification Expended Material Processing System

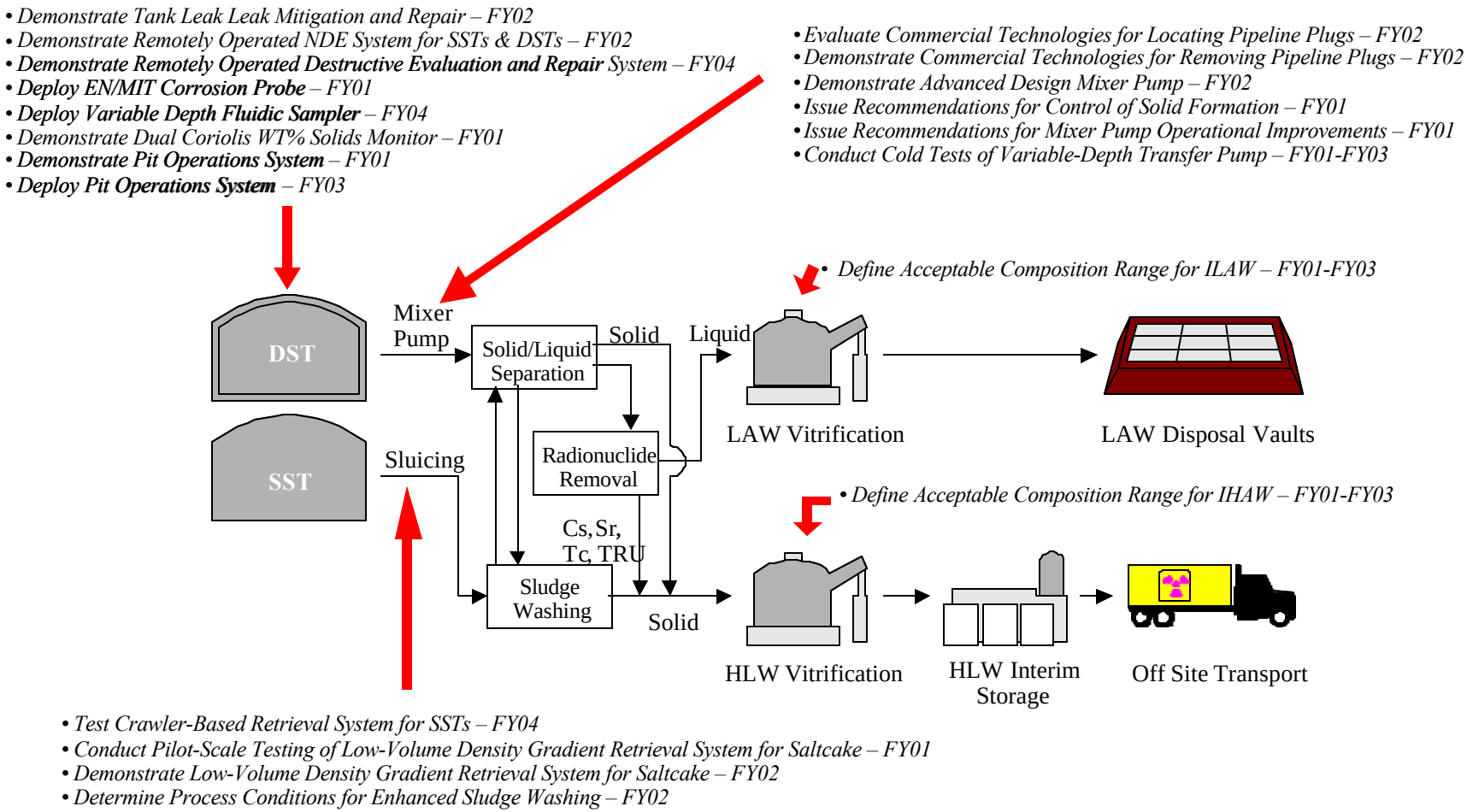

Figure 5.2. Hanford Path to Closure

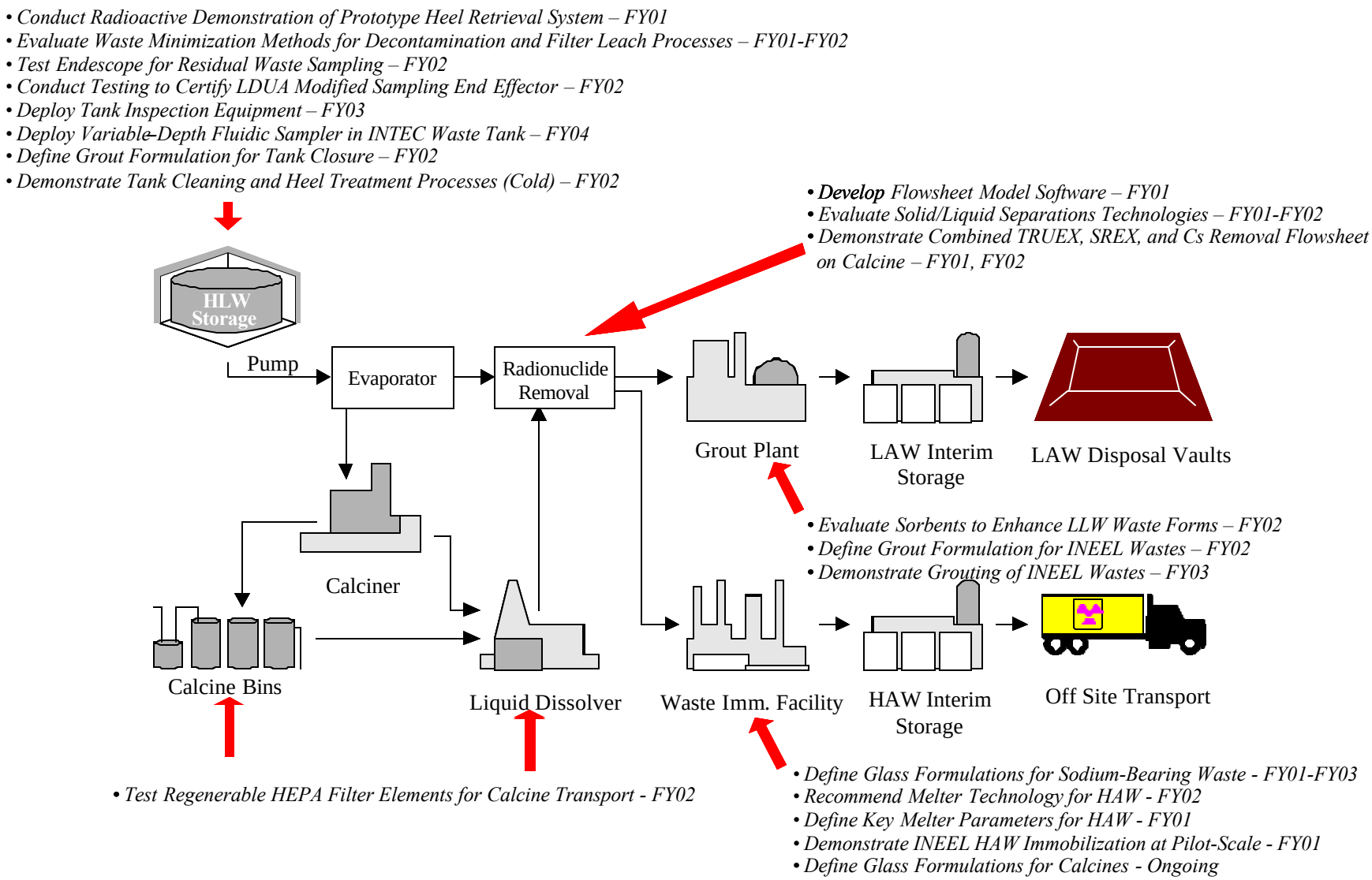

Figure 5.3. Idaho National Engineering and Environmental Laboratory Path to Closure

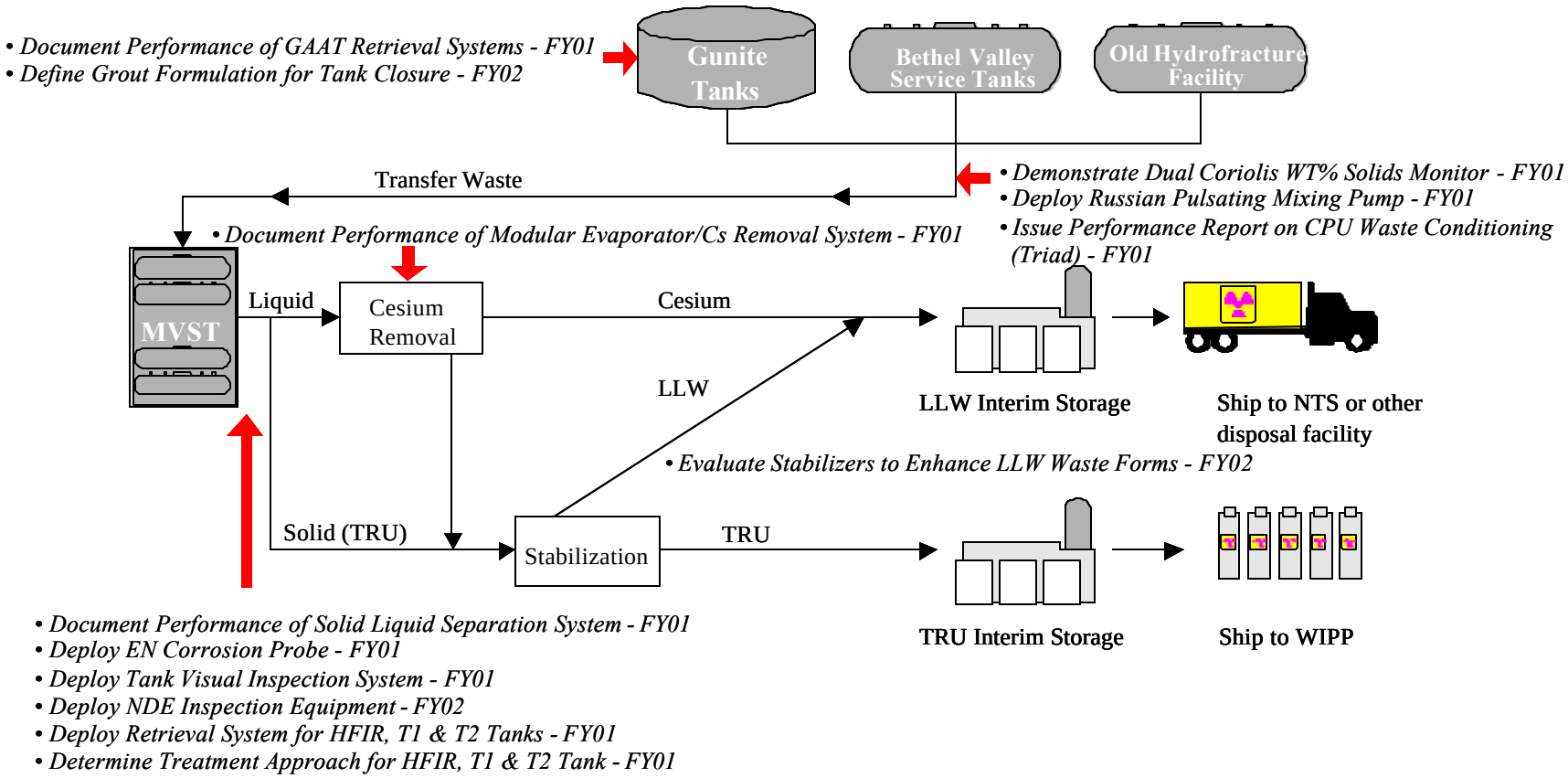

Figure 5.4. Oak Ridge Reservation Path to Closure

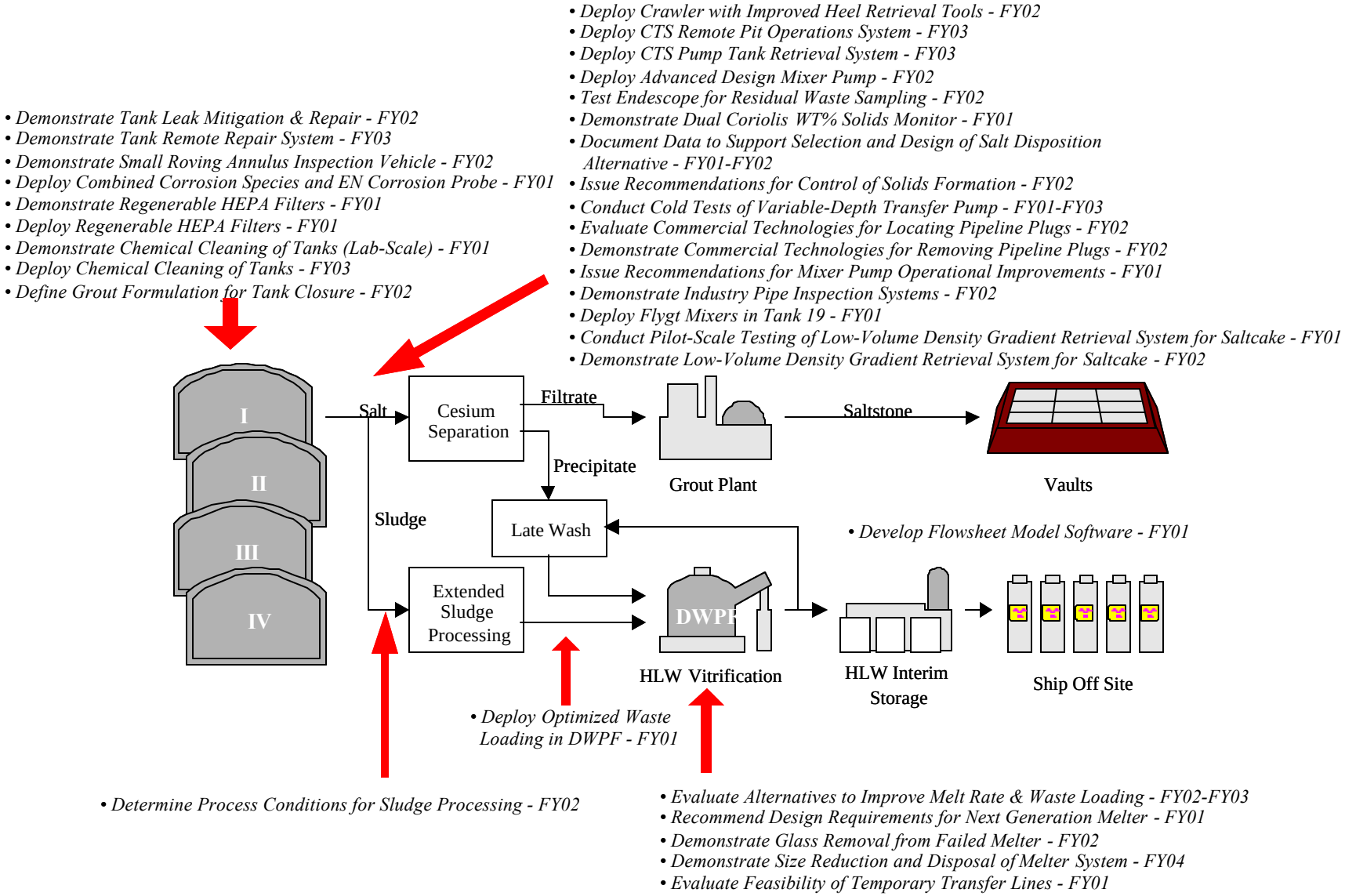

Figure 5.5. Savannah River Site Path to Closure

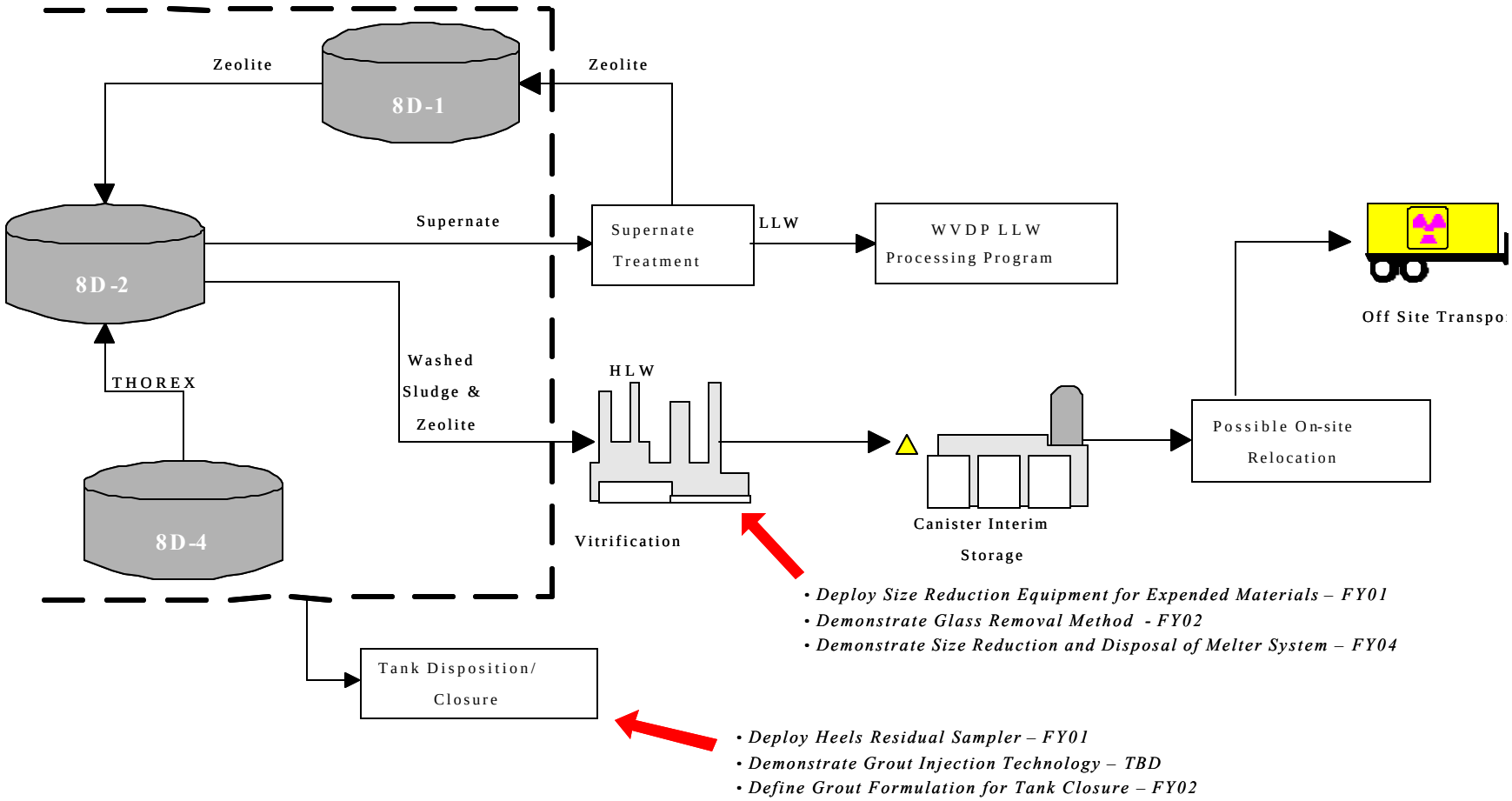

Figure 5.6. West Valley Demonstration Project Path to Closure

Problem Element 1.1.1.1 Monitor Tank Integrity/Avoid Corrosion

Problem Element 1.1.1.1 Description and Priority Site Needs

Tank integrity and corrosion avoidance are critical issues during both long-term storage and retrieval of radioactive tank wastes. 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 NDE of tank walls to determine structural integrity. Current methods are limited to contact examinations and usually require a cleaned surface and coupling between the inspection device and structure being inspected. This problem element addresses methods to avoid corrosion of steel tanks and monitor the integrity of 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. The site needs addressed in this problem element are identified below in Table 5.3.

Table 5.3. Problem Element 1.1.1.1 Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT04	DST Corrosion Monitoring	RL-TW03	EN Corrosion Probe	1985, 2015
RL-WT05	Remote Inspection of HLW Single-Shell Tanks	RL-TW03	Nondestructive Examination of Tanks	85, 130, 860, 890, 1996
RL-WT022	Adapting Tandem Synthetic Aperture Focusing Technique (TSAFT) For LAW Characterization in the Inaccessible Portion of the Knuckle Region of the DSTs.	RL-TW03	Nondestructive Examination of Tanks	85, 130, 860, 890, 1996
RL-WT067	Improved DST Integrity NDE Measurement Tools	RL-TW03	Nondestructive Examination of Tanks	
RL-WT079-S	Double Shell Tanks Corrosion Chemistry	RL-TW03	Related EMSP Projects 60219, 60401	
SR00-2035	Develop Advanced Techniques for Life Extension of Waste Tanks and Piping	SR-HL01, SR-HL02, SR-HL03	Nondestructive Examination of Tanks	85, 130, 860, 890, 1996
SR00-2037	Tank Heel Removal/Closure Technology – CTS Inspection System	SR-HL01, SR-HL02, SR-HL03	Nondestructive Examination of Tanks	

Table 5.3. (contd)

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
SR00-2045	In-Tank Corrosion Probe Development	SR-HL01, SR-HL02, SR-HL03	EN Corrosion Probe/Corrosion Species Monitor	1985, 2015
OR-TK-01	ORNL Tank Waste Characterization (Structural Integrity)	OR-311	Nondestructive Examination of Tanks	85, 130, 860, 890, 1985, 1996, 2015
OR-TK-01	ORNL Tank Waste Characterization (Corrosion Monitor)	OR-311	EN Corrosion Probe	85, 130, 860, 890, 1985, 1996, 2015
ID-2.1.20	Tank Annulus/Vault Inspection	ID-HLW-105	Nondestructive Examination of Tanks	85, 130, 860, 890, 1996
OH-WV-907	High-Level Waste Tank Interim Maintenance	OH-WV-01	Nondestructive Examination of Tanks	

Problem Element 1.1.1.1 Technical Tasks

Electrochemical Noise (EN) Corrosion Probe
(TFA Technical Response A9143; Work Package WT-04-01)

ORR, SRS, and Hanford Site need improved real-time corrosion detection systems that can help the site operators "fine tune" the amount of inhibitor needed and provide more rapid and less expensive methods to detect the corrosive characteristics of tank wastes. A corrosion probe system that provides a real-time indication of corrosion potential in HLW tanks at multiple levels or positions in the tank is needed to reduce the costs of chemical analysis and detection while providing data on tank conditions.

The electrochemical noise (EN) probe is being developed as a corrosion-monitoring tool for HLW tanks. This technique can provide real-time, on-line measurements of the corrosion processes in the tank, including the most probable processes of pitting and stress corrosion cracking. Development of the EN probe was initiated at Hanford (3 units have been deployed) and is being adapted for SRS. Development and deployment of a stainless steel probe for application at ORR is planned for FY01. Early in FY01, a final EN probe design based on the multi-function instrument tree approach will be installed in a Hanford waste tank. Data from the currently installed probes is being analyzed to validate the EN corrosion probe

as an alternative for monitoring HLW tank corrosion. At SRS, a combined EN corrosion probe/Raman corrosion species monitor (see below) will be deployed in FY01.

The EMSP is funding a project "Development of Advanced Electrochemical Emission Spectroscopy for Monitoring Corrosion in Simulated DOE Liquid Waste" (60219) that is relevant to this EN corrosion probe task. The TFA will monitor the progress of this project for application to the program.

Workscope to complete this task includes:

- Deploy fourth version of the EN probe, including improved seal and improved data collection and analysis capabilities (FY01, Hanford).
- Deploy combined EN corrosion species probe at SRS (see below) (FY01, SRS).
- Document EN corrosion probe development and final EN corrosion probe design (FY01, Hanford).
- Cold demonstration of stainless-steel EN corrosion probe for application at ORR (FY01, ORR).
- Deploy stainless-steel EN corrosion probe at ORR (FY01, ORR).

Table 5.4. Budget Profile: EN Corrosion Probe (TFA Technical Response A9143; Work Package WT-04-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL08WT21	315	15			
INEEL						
ORR	OR00WT21	315	40			
SRS (see Table 5.5)						
WVDP						
EM-50 TFA Total		630	55	0	0	0

Corrosion Species Monitor (Ion-Species Raman Probe)
(TFA Technical Response A9143; Work Package WT-04-01)

High-level liquid wastes at the SRS and Hanford are stored in carbon-steel tanks that are susceptible to nitrate ion-induced corrosion cracking. Monitoring and maintaining adequate nitrate, nitrite, and hydroxide ion levels prevents this degradation. 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 corrosion inhibitor solution. Currently, inhibitor solution containing NO_2^- 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 an $OH^-/NO_3^-/NO_2^-$ monitor could be used to control the addition of inhibitor solution.

A corrosion species monitor is being developed by CMST as a technique for real-time, on-line monitoring of waste chemistry. A robust, in situ probe that uses Raman spectroscopy for analysis is

capable of measuring the nitrite/nitrate concentration and the hydroxide concentration. EIC Laboratories are developing the Raman probe. The corrosion species monitor will be combined with an EN corrosion probe (see above) for deployment at SRS.

Workscope to complete this task includes:

- Complete cold demonstration of EIC corrosion species monitor (FY01, SRS).
- Deploy combined EN/Corrosion species probe at SRS (FY01, SRS).
- Document performance of combined EN/corrosion species probe (FY01, SRS).

Table 5.5. Budget Profile: Corrosion Species Monitor (TFA Technical Response A9143; Work Package WT-04-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS	SR18WT21	190	10	10		
WVDP						
EM-50 TFA Total		190	10	10	0	0

Nondestructive Examination (NDE) of Tanks
(TFA Technical Response A9175; Work Package WT-03-01)

The need to perform NDE 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 inspection device and structure being inspected. This is very difficult in underground storage tanks. Improved methods allowing inspections to be performed without direct contact or through liquids are needed. The knuckle region of tanks (where the 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 the quantitative data on tank structure that is needed to ensure safety of current tank configurations and evaluate side loading limits. Hanford specifically needs an NDE system for both SSTs and DSTs to support sluicing feasibility assessments and life-expectancy estimation. Systems that can be deployed using a remote device, such as the Light-Duty Utility Arm (LDUA) or other similar robotic equipment are desired. At SRS, visual and NDE inspection methods are needed to inspect tank walls and the annular space of these tanks to validate their integrity for longer-term waste storage. Visual inspection systems are also needed for the SRS Concentrate Transfer System (CTS). At ORR, routine structural integrity verification is needed before returning tanks to long-term service. At INEEL, a spare tank must be inspected as part of a certification effort to meet RCRA requirements for storage of newly generated liquid waste. Subsequent to the end of HLW processing at WVDP, the tanks must be maintained in a stable configuration pending final closure. Monitoring tank integrity to establish and maintain this stable configuration is needed.

The TFA is making a strategic investment in FY01 to develop a methodology for evaluation of stable, interim, waste tank configuration alternatives for that period of time between the end of formal waste retrieval activities and final tank closure. Following identification and evaluation of stable, interim waste storage configurations a methodology for selection of the configuration most appropriate to a specific situation will be developed. Specific criteria and application guidelines will be prepared. Typical of all applications is the constraint of limited access into the tanks to conduct the inspections. Deployment devices are therefore also needed. Also, some applications require inspecting the tanks below the waste surface level.

In FY99, INEEL used the LDUA to deploy a NDE end effector to demonstrate its applicability to inspect tank welds. The equipment was to perform tank inspection using NDE and stereo video camera end effectors.

Industry, DOE laboratories, universities, and the Center for Non-Destructive Evaluation (CNDE) are sources for technologies that will be evaluated and deployed at the sites to inspect tanks and assess their integrity.

Work activities to support the needs for tank integrity assessments will include:

<u>NDE</u>

- Identify remote inspection technologies and deployment methods for each site (FY00-FY01, SRS, INEEL, Hanford, CMST, Robotics).
  - Survey technologies available from the DOE complex, industry, and foreign companies.
  - Develop specifications and selection criteria.
  - Evaluate candidate technologies.

<u>Small Roving Annulus Inspection Vehicle</u>

- Develop requirements and specifications for small roving annulus inspection vehicle (FY01, SRS, Robotics).
- Complete development and fabrication of annulus inspection vehicle (FY01, SRS, Robotics).
- Conduct radioactive demonstration of small roving annulus inspection vehicle (FY02, SRS).

<u>Transfer Piping Photographic System</u>

- Develop requirements and specifications for piping photographic system (FY01, SRS, Robotics).
- Procure transfer piping photographic system (FY02, SRS, Robotics).
- Conduct radioactive demonstration of transfer piping photographic system (FY02, SRS).

<u>Tank Remote Repair System</u>

- Develop requirements and specifications for tank remote repair system (FY01, SRS, Robotics).
- Complete procurement of tank remote repair system (FY02, SRS, Robotics).
- Complete vendor acceptance and cold testing of tank remote repair system (FY02, SRS, Robotics).
- Conduct radioactive demonstration of tank remote repair system (FY03, SRS).

Remotely Operated NDE system for SSTs and DSTs

- Develop requirements and specifications for remotely operated NDE system (FY01, Hanford, Robotics).
- Complete development and fabrication of remotely operated NDE system (FY02, Hanford, Robotics).
- Complete vendor acceptance and cold testing of remotely operated NDE system (FY02, Hanford, Robotics).
- Conduct radioactive demonstration of remotely operated NDE system for SSTs and DSTs (FY02, Hanford).

Remotely Operated Destructive Evaluation and Repair System

- Develop requirements and specifications for remotely operated destructive evaluation and repair system (FY01, Hanford, Robotics).
- Complete fabrication and testing of prototype system for destructive evaluation and repair (FY02, Hanford, Robotics).
- Complete fabrication of full-scale remotely operated destructive evaluation and repair system (FY03, Hanford, Robotics).
- Complete cold testing of remotely operated destructive evaluation and repair system (FY04, Hanford, Robotics).
- Conduct radioactive demonstration of remotely operated destructive evaluation and repair system (FY04, Hanford).
- Deploy and monitor performance of remotely operated destructive evaluation and repair system (FY05, Hanford).

Visual Inspection and Sludge Mapping System

- Deploy visual inspection and sludge mapping system (FY01, ORR, CMST, Robotics).
- MVST Annulus External NDE Inspection Equipment.
- Develop requirements and specifications for MVST annulus inspection equipment (FY01, ORR, Robotics).
- Procure MVST annulus external NDE inspection equipment (FY02, ORR, Robotics).
- Deploy MVST annulus external NDE inspection equipment (FY02, ORR, Robotics).

INEEL Tank Inspection Equipment

- Develop requirements and specifications for INEEL tank inspection equipment (FY01, INEEL, Robotics).
- Complete fabrication and vendor acceptance testing of INEEL tank inspection equipment (FY02, INEEL, Robotics).
- Complete cold testing of INEEL tank inspection equipment (FY02, INEEL, Robotics).
- Deploy INEEL tank inspection equipment (FY03, INEEL).

Table 5.6. Budget Profile: Non-Destructive Examination (NDE) of Tanks
(TFA Technical Response A9175; Work Package WT-03-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL00WT21	220	650	200		
INEEL	ID70WT22	85	50	75		
ORR	OR00WT21	375	350	0		
SRS	SR18WT21	165	350	350		
WVDP	OH00WT21	0	100	0		
Subtotal		845	1500	625	TBD	TBD
ASTD						
CMST	CH10C211	275	125	125		
FETC						
ESP						
International						
Robotics	OR17C131 RL00C121 RL37C131 SR10C131	225 800 150 175	100 1980 275 110	0 350 350 450	200	
University						
EM-50 TFA Total		2470	4090	1900	200	TBD

Pre-Closure Interim Tank Maintenance
(TFA Strategic Technical Response AA1S1; Work Package WT-05-01)

Subsequent to the end of formal high-level waste (HLW) retrieval activities, but prior to final closure, sites will face appropriately maintaining aging tanks that still contain residual waste. These tanks must be kept in a stable configuration pending development and implementation of the final closure method-a period that may exceed 10 years. Interim maintenance would include methods for prevention of tank corrosion, monitoring the tank integrity, and implementing structural stabilization mesaures. Alternative approaches for achieving a stable, interim configuration have not been evaluated and the criteria for selection of a preferred alternative, which may vary site-to-site, has not been identified. Additionally, special equipment to monitor and maintain the tanks may need to be developed.

To address this need, the TFA is making a strategic investment to develop an interim stable tank configuration alternatives assessment tool. Workscope to address this need includes

- Develop alternatives assessment tool to support selection of most stable interim tank configuration before tank closure (FY01, FY02, WVDP, TFA, TBD)

Table 5.7. Budget Profile: Pre-Closure Interim Tank Maintenance
(TFA Strategic Technical Response AA1S1; Work Package WT-05-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS						
WVDP						
EM-50 TFA Total		150	400	TBD	TBD	TBD

Problem Element 1.1.2 Ventilate Tanks

Problem Element 1.1.2 Description and Priority Site Needs

Waste tank ventilation is necessary to maintain safe operating conditions within the tank farm. Ventilation systems and gaseous effluent treatment 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 tank ventilation and gas filtration are encompassed within this problem element. The site needs addressed in this problem element are addressed below in Table 5.8.

Table 5.8. Problem Element 1.1.2. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ID-2.1.27	Blowback Metal Filters for Solids (calcine) Retrieval	ID-HLW-103	Alternative Air Filtration Technology	2091
SR00-2027	Demonstrate Alternative Filtration Technologies to Replace HEPA Filters	SR-HL01, SR-HL02	Alternative Air Filtration Technology	2091

Problem Element 1.1.2 Technical Tasks

Alternative Air Filtration Technology
(TFA Technical Response A9171; Work Package WT-04-01)

Throughout the DOE complex, HEPA filters are used to ensure that air emissions are free of radioactive particulates from tanks and waste processing operations. The HEPA filters must be replaced when excessive material collects on the filter, causing higher pressure drop and/or dose, or when the filter fails, typically because of wetting of the filter media. During filter replacement, personnel are exposed to radiation. The used filters must then be disposed, an added cost. Washable and recyclable HEPA filters will reduce personnel exposure as well as the costs for processing and disposal of the filters.

SRS has a specific need for washable HEPA filter technology to increase the life of HLW tank HEPA filters and to reduce the volume of solid waste associated with the spent filters. At INEEL, the need is for a regenerable filter system to replace the current HEPA filters used as the final element of an air treatment system used for pneumatic transport of HLW calcine.

Laboratory testing has provided proof-of-concept that two different commercially available filter technologies can be cleaned in-place using a liquid spray system. In FY99, NETL established contracts with two commercial firms (Mott Corporation and CeraMem Corporation) to develop conceptual designs for regenerable HEPA filter systems. In parallel with the design effort, the proposed ceramic and metal filter media are being tested. Further development and deployment will depend on the design effort and filter testing.

Workscope to complete this task includes:

SRS Regenerable HEPA Filter System for Tanks

- Complete design and construction of regenerable HEPA filter system for SRS tank application (FY00, FETC).
- Conduct cold demonstration of regenerable HEPA filter system for SRS tank application (FY01, SRS).
- Deploy regenerable HEPA filter system on SRS tank (FY01, SRS).

INEEL Regenerable HEPA Filter System for Calcine Transport

- Prepare Functions and Requirements for regenerable HEPA filter system for INEEL calcine transport application (FY01, FY02, INEEL).
- Conduct tests of filter elements and systems for INEEL applications (FY02, INEEL).
- Procure regenerable HEPA filter system for INEEL calcine transport (FY03, INEEL).
- Deploy regenerable HEPA filter system for INEEL calcine transport (FY06, INEEL).

Table 5.9. Budget Profile: Alternative Air Filtration Technology (TFA Technical Response A9171; Work Package WT-04-01)

	TTP#	**FY01**	**FY02**	**FY03**	**FY04**	**FY05**
Hanford						
INEEL	ID70WT22	140	155	615		
ORR						
SRS	SR18WT21	265	265			
WVDP						
EM-50 TFA Total		405	420	615	TBD	TBD

Problem Element 1.1.3 Characterize Waste

Problem Element 1.1.3 Description and Priority Site Needs

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, hot cell analytical methods, and in situ characterization methods are needed to expedite and reduce the costs of tank waste characterization. In situ characterization and at-tank sampling and characterization are highly desired as each could provide more rapid and cost-effective waste analysis. Characterizing the waste's physical, chemical, and radiochemical properties is required for planning and implementing tank safety, retrieval, pretreatment, immobilization, and closure processes. The site needs addressed in this problem element are identified below in Table 5.10.

Table 5.10. Problem Element 1.1.3 Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ID-2.1.16	Decontaminate Facility/Analytical Facility Waste Reduction	ID-HLW-101	Validate Analytical Procedures for Rad Waste Samples	127
ID-2.1-26	Direct Tank Sampler for Tank Solution Characterization	ID-HLW-101	Waste Sampling and At-Tank Analysis	85, 860, 2119
ID-2.1.43	Certify LDUA Sampler as EPA-Approved Method of Sampling Tank Heel Liquids	ID-HLW-103 ID-HLW-105	Waste Sampling and At-Tank Analysis	85, 860
ID-2.1.44	Certify LDUA Sampler as EPA-Approved Method of Sampling Tank Heel Solids	ID-HLW-103 ID-HLW-105	Waste Sampling and At-Tank Analysis	85, 860
ID-2.1.67	High Level Waste Slurry Handling	ID-HLW-103	Slurry Transfer and Tank Waste Mixing Monitors	
ID-2.1.72	Alternate Heel Sampling System	ID-HLW-103	Residual Waste Sampling	
SR00-2037	Tank Heel Removal/Closure Technology – CTS Heel Sampler	SR-HL01, SR-HL02, SR-HL03	Residual Waste Sampling	
SR00-2037	Tank Heel Removal/Closure Technology – Real Time Rheological Properties	SR-HL01, SR-HL02, SR-HL03	Slurry Transfer and Tank Waste Mixing Monitors	279, 1547, 2236
SR00-2044	In-Situ Technology for Waste Characterization - Rheological Properties	SR-HL01, SR-HL02, SR-HL03	Slurry Transfer and Tank Waste Mixing Monitors	279, 1547, 2236
SR00-2044	In-Situ Technology for Waste Characterization – Sludge Mapping	SR-HL01, SR-HL02, SR-HL03	Sludge Mapping and Volume Estimates	

Table 5.10. (contd)

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
SR00-2044	In-Situ Technology for Waste Characterization – Buried Obstructions	SR-HL01, SR-HL02, SR-HL03	Sludge Mapping and Volume Estimates	
SR00-2044	In-Situ Technology for Waste Characterization – Radionuculide		In-situ Waste Characterization	
OR-TK-04	ORNL Sludge Mixing and Slurry Transport	OR-321, OR-322	Slurry Transfer and Tank Waste Mixing Monitors	279, 1547, 2236
RL-WT01	Technetium-99 Analysis in Hanford Tank Waste and Contaminated Tank Farm Areas	RL-TW01	Validate Analytical Procedures for Rad Waste Samples	127
RL-WT09	Representative Sampling and Associated Analysis to Support Operations and Disposal	RL-TW01 RL-WT05	Waste Sampling and At-Tank Analysis	2119, 2235
RL-WT031-S	Rapid Waste Characterization	RL-TW01	Related EMSP Projects 54674, 55318, 60075, 60217	
RL-WT032-S	Monitoring of Key Waste Physical Properties During Retrieval and Transportation	RL-TW04	Related EMSP Projects 54890, 55179	
RL-WT052-S	Characterization of Organic Species in Waste Feed to LAW and HLW Treatment Facilities	RL-TW01	Related EMSP Projects 59978, 65340, 65425	
RL-WT054-S	Develop Improved Radiochemical Analysis for High Ionic Strength Samples	SR-HL01 SR-HL02		
RL-WT065	Direct Inorganic and Organic Analyses of High Level Waste	RL-TW04	Validate Analytical Procedures for Rad Waste Samples	127
RL-WT083	Rapid PCB Screening Technology	RL-TW04	Validate Analytical Procedures for Rad Waste Samples	
OH-WV-906	Radioactivity Measurement of High-Level Waste Tank Residuals	OH-WV-01	In-situ Waste Characterization	

Problem Element 1.1.3 Technical Tasks

Waste Sampling and At-Tank Analysis
(TFA Technical Response A9246; Work Package WT-01-01)

A sampling system capable of obtaining representative waste samples is needed to support ex-situ waste characterization at Hanford and INEEL. The sampler should work with non-homogeneous wastes, rapidly obtaining samples at multiple heights and during tank mixer operation. The sampler should be capable of taking RCRA-compliant samples of the waste. Hanford also has a need for an at-tank analysis system to facilitate rapid chemical analyses for feed staging and process control. INEEL also has a need to upgrade a sampling end effector for the LDUA to obtain more representative sludge/liquid samples.

AEAT developed a fixed-depth fluidic sampler that was successfully deployed at SRS. A variable-depth fluidic sampler based on this single-sample point design is being developed for sampling wastes at Hanford and INEEL. In FY00, proof-of-concept RCRA-compliant sampling was demonstrated by AEAT.

Workscope to complete this task includes:

- Complete detailed design package for a variable-depth fluidic sampler and mobile deployment platform (FY01, AEAT, Hanford).
- Complete fabrication of a variable-depth fluidic sampler for Hanford (FY02, AEAT).
- Complete cold acceptance tests of a variable-depth fluidic sampler and at-tank slurry monitoring system (see below) for Hanford (FY03, Hanford, CMST, AEAT).
- Deploy variable-depth fluidic samplers at Hanford and INEEL (FY04, EM-30 funded).

To sample tank heels, INEEL will use a sampler end effector on the LDUA. The Heel Sampling End Effector was used to obtain waste heel samples from three INTEC tanks in FY99 and FY00. Problems encountered with plugging the sampling end effector requires that the sampler be modified to obtain more representative samples of the INTEC sludge/liquid mixtures. Workscope to complete this task includes:

- Conduct testing of prototype modifications to the Heel Sampling End Effector to determine the best design option (FY01, INEEL).
- Fabricate a modified LDUA Heel Sampling End Effector for radioactive applications (FY02, INEEL).
- Conduct testing to certify the modified LDUA Heel Sampling end effector (FY02, INEEL).
- Deploy the modified LDUA Heel Sampling End Effector (FY02, INEEL).

Table 5.11. Budget Profile: Waste Sampling and At-Tank Analysis (TFA Technical Response A9246; Work Package WT-01-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL00WT22	650				
INEEL	ID77WT22	200	150			
ORR						
SRS						
WVDP						
Subtotal		850	150	0	0	0
ASTD						
CMST						
NETL						
ESP						
International	HQ06OS11	350	790			
Robotics						
University						
EM-50 TFA Total		1200	940	0	0	0

Slurry Transfer and Tank Waste Mixing Monitors
(TFA Technical Response A9278; Work Package WT-08-01)

The physical and chemical properties of tank waste must meet operational requirement for retrieval and pretreatment operations to be successful. Particle size, weight percent solids, and chemistry changes occurring during retrieval impact the efficiency of downstream pretreatment operations. At Hanford, ORNL, and SRS, transfer line pluggage is an operational concern. In-tank and pipeline monitors are needed to measure slurry density, viscosity, solids content, particle size distribution, and flow rate before and during retrieval and transport of wastes to guard against transport line plugging. Real-time rheological property data is needed at SRS to support deployment of waste mixing equipment. A slurry monitoring system is now planned to meet the at-tank analysis requirements at Hanford.

To address these needs, the TFA and CMST are evaluating slurry monitors and rheological property instrumentation. Hot field tests of in-line slurry monitors (i.e., an Endress + Hauser coriolis flow/density monitor, an Argonne National Laboratory (ANL) ultrasonic weight percent solids monitor, and a Lasentec particle size distribution monitor) were conducted at ORNL in FY99. A dual coriolis monitor system is being developed to measure weight percent solids in tank slurries. A slurry monitor to predict pipeline plugging will be evaluated for deployment.

The EMSP has funded two projects, “On-Line Slurry Viscosity and Concentration Measurement as a Real-time Waste Stream Characterization Tool” (54890) and “Acoustic Probe for Solid-Gas Liquid Suspensions” (55179) that are relevant to this task.

Workscope to complete this task includes:

Dual Coriolis Weight Percent Solids Monitor

- Design and fabricate a dual coriolis weight percent solids monitor (FY01, CMST, University Program).
- Complete a cold demonstration of the dual coriolis weight percent solids monitor (FY01, CMST, University Program).
- Deploy the dual coriolis weight percent solids monitor at SRS and ORR (FY02, SRS, CMST).

Slurry Monitor and Measurement Systems (Not Funded in FY01)

- Define requirements for a slurry monitoring and measurement systems for Hanford and INEEL.
- Complete design of an at-tank slurry monitoring system.
- Fabricate an at-tank slurry monitoring system.
- Conduct cold tests of an at-tank slurry monitoring system.
- Deploy an at-tank slurry monitoring system.

Table 5.12. Budget Profile: Slurry Transfer and Tank Waste Mixing Monitors (TFA Technical Response A9278; Work Package WT-08-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS						
WVDP						
Subtotal						
ASTD						
CMST	FT00C211	500	350	300		
NETL						
ESP						
International						
Robotics						
University						
EM-50 TFA Total		500	350	300	TBD	TBD

Residual Waste Sampling
(TFA Technical Response AA203; Work Package WT-02-01)

Sampling devices are needed to obtain liquid and sludge samples from small process tanks, tanks with small-diameter access ports, and tank annuli. INEEL has a need to retrieve samples from the vault sump on the bottom of the annulus space of their HLW tanks and from other small process vessels and tanks. SRS has a need to inspect and sample evaporators and CTS vessels.

To address these needs, a small-diameter steerable tool will be developed that can access tanks and vessels through 1- to 2-inch diameter process lines with sufficient articulation and control to inspect and

sample desired locations. The TFA will leverage work already in progress by AEAT and funded by the D&D Focus Area. A commercially available 65- to 150-foot steerable cable (endescope) is being adapted for inspection and sampling. This endescope will be cold tested in FY00.

Workscope to complete this activity includes:

- Develop functions and requirements for an endescope sampling and inspection tool (FY01, SRS, INEEL).
- Design and fabricate a prototype endescope sampling and inspection tool (FY01, AEA).
- Conduct cold demonstration of a prototype endescope sampling and inspection tool (FY01, AEA, SRS, INEEL).
- Design and fabricate endescope sampling and inspection tools for deployment (FY02, AEA).
- Conduct cold testing of endescope sampling and inspection tools (FY02, AEA, SRS, INEEL).
- Deploy endescope sampling and inspection tools (FY02, SRS, INEEL).

Table 5.13. Budget Profile: Residual Waste Sampling (TFA Technical Response AA203; Work Package WT-02-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL	ID77WT22	125	150	50		
ORR						
SRS	SR18WT21	125	150	50		
WVDP						
Subtotal		250	300	100	0	0
ASTD						
CMST						
NETL						
ESP						
International	HQ06PS11	400	300			
Robotics						
University						
EM-50 TFA Total		650	600	100	0	0

In-Situ Waste Characterization
(TFA Technical Response AA202; Work Package WT-02-01)

In situ methods for characterization of wastes are desired in order to reduce sampling and analysis times, reduce personnel exposure, and minimize the generation of secondary wastes. In-situ characterization methods are also needed to measure residual waste inventories during the final phases of waste removal operations and to determine when the tank has been cleaned to a level to meet closure requirements.

To address the need for in situ waste characterization at SRS and Hanford, the following workscope will be conducted:

- Develop function and design requirements for an in situ waste characterization method.
- Develop and evaluate conceptual designs for in-tank or at-tank analytical systems and deployment platforms.
- Design and fabricate an in-tank or at-tank analytical system and deployment platform.
- Conduct a cold demonstration of the in-tank or at tank analytical system and deployment platform.
- Deploy the in-tank or at-tank analytical system and deployment platform.

To address the need for surveying residual waste inventories, WVDP is adapting commercially available monitors to the MTDS deployment platform. To support this activity, TFA is supporting detailed design for the survey instrumentation, cold testing, and deployment.

Table 5.14. Budget Profile: In-Situ Waste Characterization
(TFA Technical Response AA202; Work Package WT-02-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL00WT22	225				
INEEL						
ORR						
SRS						
WVDP						
EM-50 TFA Total		225				

Improve Waste Analytical Methods
(TFA Technical Response A9264; Work Package WT-11-01, unfunded)

Hanford, INEEL, and SRS need to develop and validate analytical procedures to address specific site requirements and issues. Hanford needs to validate, per EPA protocol or equivalency guidelines, existing laboratory procedures for waste samples. Hanford and INEEL have needs for analysis methods that minimize secondary waste generation, minimize sample volumes, reduce analysis time, and reduce worker radiological exposure. Hanford needs to validate laboratory procedures for Tc-99 analyses to increase confidence in contaminant inventory estimates. To address these needs, the TFA will:

- Facilitate communications among the DOE sites regarding validation or demonstrating equivalency to EPA approved analytical methods.
- Optimize and upgrade LA/MS equipment and procedures for quantitative elemental analysis of solid samples. Validate LA/MS technology through round-robin testing of standard materials and through continuance of EMSP fundamental studies of the laser ablation process.
- Conduct round-robin tests among laboratories across the DOE complex to validate Tc-99 analytical methods.
- Evaluate current analytical procedures and improve upon those methods to reduce secondary waste generation.

The EMSP is funding a number of projects that are relevant to improving waste analytical methods. Included are:

- "Improved Analytical Characterization of Solid Waste Forms by Fundamental Development of Laser Ablation Technology" (55318).
- Particle Generation by Laser Ablation in Support of Chemical Analysis of High-Level Mixed Waste from Plutonium Production Operations" (60075).
- "Design and Development of a New Hybrid Spectroelectrochemical Sensor" (54674).
- "Optically Based Array Sensors for Selective In Situ Analysis of Tanks" (60217).
- "Thermospray Mass Spectrometry Ionization Processes Fundamental Mechanisms for Speciation, Separation, and Characterization of Organic Complexants in DOE Wastes" (59978).
- "Detection and Characterization of Chemicals Present in Tank Wastes" (65340).
- Mass Spectrometric Fingerprinting of Tank Waste Using Tunable, Ultrafast Infrared Lasers" (65425).
- "Ion Recognition Approach to Volume Reduction of Alkaline Tank Waste by Separation and Recycle of Sodium Hydroxide and Sodium Nitrate" (65339).

Sludge Mapping and Volume Estimates
(TFA Technical Response AA201; Work Package WT-11-01, unfunded)

The mobilization of sludge during tank mixing and waste retrieval operations can create an uneven distribution of sludge on the tank bottom. Obstructions beneath waste liquids and sludges can also impact waste distribution. To improve waste mixing and mobilization, methods to map obstructions and waste sludge distribution through the supernate are needed.

Technology development for sludge and obstruction mapping has focused on laser mapping and range finding using visible light and the use of ultrasonic probes to detect objects. A preliminary testing and feasibility study is needed for technology selection and system design.

Workscope to complete this task includes:

- Develop function and design requirements for a sludge mapping and obstacle location system.
- Test the feasibility of candidate technologies for sludge and obstacle mapping.
- Design and fabricate a sludge mapping and obstacle location system.
- Conduct a cold demonstration of a sludge mapping and obstacle location system.
- Deploy a sludge mapping and obstacle location system.

Problem Element 1.1.4 Reduce Waste Volumes

Problem Element 1.1.4 Description and Priority Site Needs

Secondary wastes, such as contaminated water from off-gas treatment systems, are generated during processing of tank wastes. Some liquid streams are 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 space and reduce life-cycle cost by reducing the volume of waste re-entering process plants. 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, tank-to-tank transfers to solve waste storage problems, or tank waste processing operations. The site needs addressed by this problem element are identified below in Table 5.15.

Table 5.15. Problem Element 1.1.3 Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ID-2.1.16	Decontamination Facility/Analytical Facility Waste Reduction	ID-HLW-101	Decon and Filter Process Waste Volume Reduction	
ID-2.1.17	Develop New Filter Leach Process	ID-HLW-101	Decon and Filter Process Waste Volume Reduction	
ID-2.1.29	Evaluate Chloride Corrosion Potential (LET&D/PEWE/Future Processes)	ID-HLW-101	Removal of Chloride from INEEL Waste Solutions	
ID-2.1.30	Remove/Treat Chlorides (LET&D/PEWE/Future Processes)	ID-HLW-101	Removal of Chloride from INEEL Waste Solutions	TBD
ID-2.1.36	Mercury Removal from Liquid Wastes	ID-HLW-101	Removal of Mercury from INEEL Waste Solutions	TBD
ID-2.1.56	Mercury Treatment for Aluminum Calcine	ID-HLW-103	Removal of Mercury from INEEL Waste Solutions	TBD

Table 5.15. (contd)

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ORTK-05	Tank Sludge and Supernatant Separation	OR-151 OR-311	Evaporation and/or Separations Pretreatment Deployment	
ORTK-11	Tank Supernatant Pretreatment	OR-311	Evaporation and/or Separations Pretreatment Deployment	
SR00-2033	Provide Alternative Processing and/or Concentration Methods for DWPF Recycle Aqueous Streams	SR-HL01 SR-HL02 SR-HL05	Vitrification Recycle	

Problem Element 1.1.4 Technical Tasks

Decon and Filter Process Waste Volume Reduction
(TFA Technical Response A9508; Work Package WT-04-01)

Aggressive reductions in waste generation at INEEL are required to meet State of Idaho and DOE-ID goals to complete environmental management and treatment of current waste inventories. Several facilities at the INTEC, particularly the equipment decontamination facility and the filter leach facility, are significant liquid waste generators. By reducing the waste generation to the tank farm, meeting the Settlement Agreement schedule or deadline becomes more achievable. Workscope to address this need includes:

Waste Reduction from Decontamination Processes

- Conduct radioactive demonstration of Siemen's HP/CORD decontamination method (FY01, INEEL).
- Evaluate commercial and Russian decontamination methods (FY01, INEEL).
- Deploy selected technologies to minimize liquid waste generation during equipment decontamination (FY02, INEEL).

Waste Minimization from Filter Leach Process

- Document work to develop and evaluate methods for direct solidification of HEPA filter media (FY01, INEEL).
- Conduct laboratory-scale tests of methods to enhance/replace the pulp processing filter leach process (FY01, INEEL).

- Prepare specifications for pilot-scale equipment to demonstrate selected HEPA filter treatment process (FY02, INEEL).
- Conduct pilot-scale testing of selected HEPA filter treatment process (FY03, INEEL).

Table 5.16. Budget Profile: Decon and Filter Process Waste Volume Reduction (TFA Technical Response A9508; Work Package WT-04-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL	ID70WT32	500	500	300		
ORR						
SRS						
WVDP						
EM-50 TFA Total		500	500	0	0	0

Vitrification Recycle
(TFA Technical Response A9566; Work Package WT-08-01)

SRS is considering installation of an evaporator in its Defense Waste Processing Facility (DWPF) in order to reduce the volume (>2 million gallons per year) of the recycle stream currently flowing back to tank farms. The feasibility of this approach needs to be evaluated, including waste chemistry, materials corrosion, and process considerations. Workscope to address this need includes:

- Conduct laboratory evaporation tests to determine potential operational problems and control strategies (FY01, TBD).
- Conduct corrosion studies on materials of construction (FY01 FY02, TBD).
- Provide technical support to design and startup (FY02, TBD).

Table 5.17. Budget Profile: Vitrification Recycle (TFA Technical Response A9566; Work Package WT-08-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS						
WVDP						
EM-50 TFA Total		600	650	0	0	0

Evaporation and/or Separations Pretreatment Deployment
(TFA Technical Response A9586; Work Package WT-09-01)

Mixed RH-TRU sludge and mixed non-TRU supernates stored in the Gunite and Associated Tanks (GAAT), the Old Hydrofracture Tanks (OHF), and the Bethel Valley Evaporator Service Tanks (BVEST) at ORR is being retrieved, conditioned, transferred, and consolidated in the Melton Valley Storage Tanks (MVST). The Wastewater Triad Project (WTP) contains solid/liquid separations, cesium removal, and evaporation processes for treating these wastes. During FY99 and FY00, the WTP successfully processed 10 MVSTs. In FY01, data from the processing of concentrated and dilute wastes will be analyzed and the performance of the WTP will be documented.

Table 5.18. Budget Profile: Evaporation and/or Separations Pretreatment Deployment (TFA Technical Response A9586; Work Package WT-09-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS						
WVDP						
Subtotal		0	0	0	0	0
ASTD	OR08SD11	200				
CMST						
NETL						
ESP						
International						
Robotics						
University						
EM-50 TFA Total		200	0	0	0	0

Removal of Mercury from INEEL Waste Solutions
(TFA Technical Response A9518; Work Package WT-11-01, unfunded)

Removal of mercury (Hg) is required to accomplish INEEL near-term waste management strategies by eliminating the Hg recycle to the waste tanks, thereby reducing the volume of waste requiring extensive treatment. Technologies are needed to remove Hg from INEEL off-gas treatment solutions, sodium-bearing wastes, and newly generated liquid wastes and from dissolved calcines that are planned for thermal treatment. Removal of Hg from DWPF recycle streams remains an SRS technology need. Both INEEL and SRS, through the ESP, have examined Hg removal methods. Workscope to complete this task includes:

- Evaluate alternative Hg removal technologies.
- · Conduct lab-scale demonstration of Hg removal from actual waste solutions (INEEL).
- Conduct bench and pilot-scale testing on methods to remove Hg from dissolved calcine .

Removal of Chloride from INEEL Waste Solutions
(TFA Technical Response A9514; Work Package WT-09-01, unfunded)

The need for chloride removal from INEEL waste treatment solutions is anticipated to minimize corrosion of primary and secondary waste treatment processes. To address this need, the following tasks must be completed:

- Assess state of knowledge on corrosion studies on INEEL materials of construction.
- Identify and evaluate alternative methods for removing chlorides from INTEC wastes.
- Demonstrate selected chloride removal methods.

Problem Element 1.2.1.2 Mobilize Bulk and Heel Wastes

Problem Element 1.2.1.2 Description and Priority Site Needs

Mobilizing bulk and heel wastes within a tank is required for tank waste retrieval and treatment, for ultimate immobilization and disposal of the hazardous waste components, and for tank closure. 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. In addition to responding to site needs, the TFA is making strategic investments to investigate selective chemical dissolution to enhance heel retrieval and to investigate retrieval methods from leaking tanks. The site needs addressed by this problem element are identified below in Table 5.19.

Table 5.19. Problem Element 1.2.1.2 Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT013	Establish Retrieval Performance Evaluation Criteria (SST Retrieval Enhancements)	RL-TW04	Unobstructed Tank Heel Retrieval	812, 1510, 1511, 1547, 1989, 2011, 2012, 2097 2117, 2232, 2366, 2370
RL-WT054-S	Solids Yield During Mixer Pump Mobilization	RL-TW04		
RL-WT060	Better Waste Mixing Mobilization	RL-TW04	Waste Mixing and Retrieval	1511, 2097, 2115, 2232, 2370
RL-WT063	PHMC Retrieval and Closure – Hanford SST Saltcake Dissolution Retrieval	RL-TW04	Saltcake Dissolution Retrieval	1989
RL-WT064	PHMC Retrieval and Closure – Hanford Past Practice Sluicing Improvements	RL-TW04	Unobstructed Tank Heel Retrieval	812, 1510, 1511, 1989, 2011, 2012, 2097, 2117, 2232, 2366, 2370
RL-WT077-S	Improvements to Salt Well Pumping	RL-TW04		

Table 5.19. (contd)

STCG Need Number	Need Title	PBS Numbe r	Technical Task	OST Number
RL-WT085	Retrieval of Waste Heel from 340 Radioactive Liquid (Low-Level / Mixed Waste Vault) Vault	RL-WM05	Horizontal and Small Tank Sludge Mixing and Mobilization	
SR00-2028	Alternative Waste Removal Technology	SR-HL01, SR-HL02, SR-HL03	Waste Mixing and Retrieval Saltcake Dissolution Retrieval	1511, 2097, 2115, 2232, 2370
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-HL03	Waste Mixing and Retrieval Chemical Cleaning of Tanks Unobstructed Tank Heel Retrieval Horizontal and Small Tank Sludge Mixing and Mobilization Waste Retrieval from Confined Spaces	812, 1510, 1511, 1989, 2011, 2012, 2097, 2117, 2232, 2366, 2370
SR00-2041	Develop Advanced Mixing Technology	SR-HL01, SR-HL02, SR-HL03	Waste Mixing and Retrieval	1511, 2097, 2115, 2232, 2370
ID-2.1.50	Solids Waste (Calcine) Retrieval	ID-HLW-103	Dry Solid Wastes Retrieval	N/A
ID-2.1.67	High Level Waste Slurry Handling	ID-HLW-103	Heel Retrieval from Obstructed Tanks	
ID-2.1.69	Solids Waste (Calcine) Retrieval from CSSF1	ID-HLW-103	Dry Solid Wastes Retrieval	
OH-WV-905	Retrieval of Tank Heels	OH-WV-01	Heel Retrieval from Obstructed Tanks Horizontal and Small Tank Sludge Mixing and Mobilization	

Table 5.19. (contd)

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
OR-TK-02	ORNL Tank Solid Waste Retrieval	OR-321	Waste Mixing and Retrieval Unobstructed Tank Heel Retrieval Horizontal and Small Tank Sludge Mixing and Mobilization	812, 1510, 1511, 1989, 2011, 2012, 2097, 2117, 2232, 2366, 2370

Problem Element 1.2.1.2 Technical Tasks

Waste Mixing and Retrieval
(TFA Technical Response A9359; Work Package WT-02-01)

This activity combines Hanford and SRS needs for mixer pump retrieval enhancements. Mixer pump retrieval consists of waste mobilization and transfer out of the tank. SRS is resuming sludge retrieval using its baseline long-shaft mixers. They need to optimize their operational strategy so that as much sludge as possible can be sent to DWPF as feed. This will require testing of multiple pump retrieval interactions. Hanford may use the results of the SRS work for long-shaft mixer equipment and operational improvements as candidate recommendations for their sludge retrieval activities. Hanford needs additional sludge mobilization methods to retrieve sludge that is beyond the Effective Cleaning Radius (ECR) of the baseline pair of long-shaft mixer pumps. The objective is a small system that can be installed in the tanks along with the mixers when needed to mobilize remaining sludge. Both Hanford and SRS are interested in identifying replacements for baseline mixer pumps with more cost-effective alternates, especially with respect to life cycle and operations costs for bulk sludge, sludge heel, and saltcake retrieval. This need exists for large HLW storage tanks and for smaller process tanks, such as SRS transfer system pump tanks. SRS also desires recommendations for equipment enhancements, such as a small diameter 300 Hp slurry pump, or a pump deployment system that simplifies elevation changes. Safety impacts to Authorization Bases also need to be evaluated.

As ORR completes deployment of the Russian Pulsating Mixer Pump (PMP), the performance of the system must be evaluated and documented.

To address these needs, the TFA is funding work to develop improved/alternate design mixer pumps, complete the deployment and evaluation of the Flygt mixers and Russian Pulsating Mixer Pump, and investigate mixer-pump operational improvements. Other work to evaluate alternative mixer

systems, including replacements for long-shaft pumps, low-shear mixers, and degassing mixers, will be conducted in the future as budgets allow. Dynamic mixer modeling and sluicing enhancements will also be considered in the out years.

Workscope to complete these activities includes:

Improved/Alternate Design Mixer Pumps

- Define requirements for hot deployment of the ADMP (FY01, TFA, SRS, Hanford).
- Complete modifications to the ADMP (FY01, TFA, SRS).
- Assess the ADMP at SRS for deployment (FY02, TFA, SRS).
- Evaluate and document the performance of the ADMP (FY02, TFA, SRS).

Flygt Mixers

- Complete deployment of Flygt mixers at SRS (FY01, TFA, SRS, Hanford).
- Document the performance of Flygt mixers (FY01, TFA, SRS, Hanford).

Russian Pulsating Mixer Pump (PMP)

- Complete deployment of the Russian PMP (FY01, TFA, ORR).
- Evaluate and document the performance of the Russian PMP (FY01, TFA, ORR).

Mixer Pump (Slurry Pump) Operational Improvements

- Complete mixer pump tests, evaluate the results, and recommend operational requirements for best pump performance (FY01, TFA, SRS, Hanford).
- Demonstrate operational improvement of the SRS mixer pump (FY02, TFA, SRS).

Alternative Mixer Systems (unfunded)

- Define requirements for alternative mixer systems, including long-shaft pumps, low-shear mixers, and degassing mixers.
- Conduct feature tests on alternative mixer systems.
- Procure selected alternative mixer systems for deployment.
- Conduct cold testing of selected alternative mixer systems.
- Deploy selected alternative mixer systems.

Extended Sludge Retrieval (unfunded)

- Define requirements for an extended sludge retrieval testing.
- Conduct feature tests on alternative extended sludge retrieval technologies.
- Complete evaluation of extended sludge retrieval systems and recommend deployable systems. **Decision point for deployment.**
- Procure a system for extended sludge retrieval
- Deploy the extended sludge retrieval system

Table 5.20. Budget Profile: Waste Mixing and Retrieval (TFA Technical Response A9359; Work Package WT-02-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL09WT21 RL09WT22 RL36WT51	400 50 275	800 50 150			
INEEL						
ORR	OR16WT51	80				
SRS	SR16WT51	100	550			
WVDP						
EM-50 TFA Total		905	1550	TBD	TBD	TBD

Horizontal and Small Tank Sludge Mixing and Mobilization
(TFA Technical Response A9382; Work Package WT-02-01)

Horizontal and small vertical tanks at several DOE sites require technologies for waste retrieval and tank cleaning. These include the SRS 242-F evaporator concentrate transfer system (CTS); WVDP's tanks 8D-3 and 8D-4, the low-level waste treatment system (LWTS), and waste treatment and vitrification process vessels; ORR's tanks T1 and T2; and Hanford's miscellaneous underground storage tanks in the site's 300 Area that hold various laboratory wastes.

Several technologies have recently been demonstrated that may be applicable for retrieval of waste from small vertical tanks. These include the AEAT Fluidic Pulse Jet mixers, the Extendible Nozzle Borehole Miner, and AEAT's mobile small-tank waste retrieval system. Other retrieval equipment applied to larger tanks may also have application including Flygt mixers, the Russian Pulsating Mixer Pump (PMP), and the Scarab II remotely operated vehicle.

Workscope to complete technology delivery for horizontal and small vertical tank sludge mixing and mobilization includes:

<u>CTS Pump Tank / 1F Evaporator Retrieval Systems</u>

- Issue recommendations for the SRS CTS pump tank retrieval system (FY01, SRS, TFA).
- Define functions and requirements and specifications for the CTS pump tank retrieval system (FY01, SRS, TFA).
- Procure the CTS pump tank retrieval system (FY02, SRS).
- Conduct cold testing of the CTS and evaporator pot retrieval system (FY03, SRS).
- Deploy the CTS pump tank retrieval system (FY03, SRS, TFA).
- Document performance of the CTS pump tank retrieval system (FY03, SRS, TFA).

<u>ORR T1, and T2 Tank Retrieval System</u>

- Assemble and deploy a retrieval system for ORR HFIR tank (FY01, ORR, TFA).
- Assemble and deploy a retrieval system for ORR tanks T1 and T1 (FY01, ORR, TFA).
- Document performance of the retrieval systems for ORR HFIR, T1, and T2 Tanks (FY01, ORR, TFA).

WVDP Small Vertical Tanks

- Document the results of current pipe and miscellaneous tank cleaning technologies (FY01, WVDP, TFA).
- Procure enhanced systems for pipe and miscellaneous tank cleaning (FY01, WVDP, TFA).
- Deploy enhanced systems for pipe and miscellaneous tank cleaning (FY02, WVDP, TFA).

Table 5.21. Budget Profile: Horizontal and Small Tank Sludge Mixing and Mobilization (TFA Technical Response A9382; WT-02-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS						
WVDP						
EM-50 TFA Total		1100	500	300	TBD	TBD

Unobstructed Tank Heel Retrieval
(TFA Technical Response A9367; Work Package WT-03-01)

After conventional waste retrieval techniques remove the bulk of the wastes within a tank, tank heels usually remain. Removal of the tank heels is required to maximize the amount of waste delivered to waste treatment and immobilization processes and to minimize the amount of waste remaining in the tanks for tank closure. Heel retrieval systems are needed that 1) minimize the amount of water added to the tank, and 2) retrieve rapidly settling solids.

Heel retrieval from unobstructed tanks allows deployment of systems such as vehicles and sluicers that are unrestricted by cooling coils or other tank structures. These include SRS Type IV tanks, ORR GAAT tanks, and most Hanford SSTs. The performance of heel retrieval equipment used to date will be analyzed. Requirements will be established for retrieval of remaining waste heels. A flat tank bottom cleaning system is needed for ORR and SRS that will likely be vehicle deployed. The needed equipment will be assembled for use at ORR and SRS. Retrieval systems for removal of the remaining coarse, sand-like gunite chips and rubble from Tank W-9 at ORR will be evaluated for deployment. This material will likely not be a candidate for pipeline transfer to MVST. Alternate waste transfer methods must be evaluated. The Hanford C-106 heel retrieval project (formerly known as the Hanford Tanks Initiative) identified several alternate retrieval technologies that could be suitable to remove hard heel waste from leaking tanks; provided characterization technologies for in-tank and the vadose zone; and provided retrieval performance evaluation criteria. Hanford C-104 is now slated for demonstration of this technology. ORR has deployed the Borehole Miner in their OHF tanks and the Gunite Tank Cleaning system, consisting of the Modified Light Duty Utility Arm, Houdini, and Houdini II, the Confined Sluicing End-Effector, and the Hose Management system, in the ongoing retrieval of waste from the GAAT.

Workscope to provide technology solutions for tank heel retrieval includes:

GAAT Retrieval Closeout (ORR)

- Complete removal of chips and rubble from Tank W-9 using the MLDUA and Houdini (FY01, ORR, TFA).
- Document performance of the GAAT retrieval (FY01, ORR, TFA).
- Prepare equipment for transfer to other facilities as appropriate (FY01, ORR, TFA).

Crawler-Based Retrieval System for Hanford

- Resume industry contract for crawler-based retrieval system (FY01, Hanford, TFA).
- Procure and fabricate crawler-based retrieval system for SST retrieval (FY02-FY03, Hanford, TFA).
- Conduct cold testing of crawler-based retrieval system for SSTs (FY04, Hanford, TFA).
- Deploy a crawler-based retrieval system for Hanford SSTs (FY05, Hanford, TFA).
- Issue a recommendation document for SST heel retrieval at Hanford (FY00, FY01, Hanford, TFA).
- Design and fabricate a residual waste retrieval system for Hanford SSTs (FY02, Hanford, TFA).
- Complete testing of alternative sluicing nozzles for application in unobstructed tanks (FY00, TFA).

Heel Retrieval from Unobstructed Tanks (SRS)

- Define requirements for improved tools for a crawler system (FY01, SRS, Robotics, TFA).
- Complete design and procurement of improved tools and crawler system (FY01, SRS, Robotics, TFA).
- Deploy a crawler system with improved tools (FY02, SRS, Robotics, TFA).

Table 5.22. Budget Profile: Unobstructed Tank Heel Retrieval (TFA Technical Response A9367; Work Package WT-03-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL36WT51 RL09WT21 RL09WT22	150 650 400	100 1500	 3000		
INEEL						
ORR						
SRS						
WVDP						
Subtotal		1200	1600	3000	TBD	TBD
ASTD	OR08SD10	70				
CMST						
NETL						
ESP						
International						
Robotics	OR17C131 SR10C131	50 350	 250			
University						
EM-50 TFA Total		1670	1850	3000	TBD	TBD

Heel Retrieval from Obstructed Tanks
(TFA Technical Response A9361; Work Package WT-03-01)

Some waste storage tanks contain internal structures that obstruct attempts to retrieve waste heels. These include SRS Type I, II, and III Tanks, INEEL HLW tanks, WVDP HLW tanks, and some Hanford SSTs. INEEL needs a retrieval system for removing sludges recently identified in their HLW tanks. WVDP is completing retrieval operations and needs to sample residual wastes to determine cleanliness levels. Workscope to provide technology solutions for tank heel retrieval from obstructed tanks includes:

INEEL Heel Retrieval System

- Complete cold testing of Spray Ball and Steam Jet retrieval systems (FY01, INEEL, Robotics, TFA).
- Conduct a radioactive demonstration of a prototype retrieval system (FY01, INEEL, Robotics, TFA).
- Develop a conceptual design for an INEEL heel retrieval system (FY02, INEEL, TFA).
- Develop retrieval processes and tools for INEEL's heel retrieval system (FY02-FY03, INEEL, Robotics, TFA).
- Conduct cold testing of a prototype INEEL heel retrieval system (FY03-FY04, INEEL, Robotics, TFA).

Heel Residuals Samples

- Complete design and fabrication of a heel residuals sampler (FY01, WVDP, Robotics, TFA).
- Deploy a heels residual sampler (FY01, WVDP, TFA).
- Provide the technical basis to support an NRC incidental waste determination (FY01, WVDP, TFA).

Table 5.23. Budget Profile: Heel Retrieval from Obstructed Tanks (TFA Technical Response A9361; Work Package WT-03-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL36WT51	50	200	250		
INEEL	ID70WT21	500	200	400	350	
ORR						
SRS						
WVDP	OH00WT22	350				
Subtotal		900	400	650	350	TBD
ASTD						
CMST						
NETL						
ESP						
International						
Robotics	OR17C131	150	200	250		
University						
EM-50 TFA Total		1050	600	900	350	TBD

Chemical Cleaning of Tanks
(TFA Technical Response A9363; Work Package WT-05-01)

The primary goal of chemical cleaning is to remove all the residual contaminants from a waste tank. However, when this is not practical, enhancing the removal of Tc-99 is desirable because Tc-99 has the highest public dose potential after tank closure. Tc-99 becomes more soluble when oxidized, so oxidizing chemical treatments, such as peroxides or ozone, could be effective. Development of improved chemical cleaning methods with the assistance of Russian scientists will lead to recommendations for hot chemical cleaning methods in FY01. Primary issues include criticality safety during waste dissolution or softening, prevention of tank walls and floor disintegration, and improved methods that minimize impacts on downstream treatment processes. Chemical cleaning developments will consider bulk sludge removal, residual heel removal, and selective Tc-99 removal. Investigation of using chemical additions to enhance mechanical retrieval methods will also be evaluated, particularly related to increasing retrieval performance in obstructed tanks.

Workscope to provide technology solutions for tank heel retrieval using chemical cleaning includes:

- Conduct a radioactive laboratory-scale demonstration of chemical cleaning methods for SRS wastes (FY01-FY02, SRS, TFA).
- Conduct cold tests of chemical cleaning methods for INEEL tank heels (FY02, INEEL, TFA).
- Conduct radioactive laboratory tests of chemical cleaning methods for INEEL tank heels (FY03, INEEL, TFA).
- Deploy a chemical cleaning system at SRS (FY03-FY04, SRS, TFA).
- Document the performance of a chemical cleaning system (FY04, SRS, TFA).
- Issue a report on Khlopin Radium Institute studies of chemical cleaning methods, including methods to soften bulk hardened sludges, to retrieve INEEL heels, and to selectively remove Tc-99 (FY01, FY02, FY03, Khlopin Radium Institute, TFA).

Table 5.24. Budget Profile: Chemical Cleaning of Tanks (TFA Technical Response A9363; Work Package WT-05-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL	ID70WT21	50	200	400		
ORR						
SRS	SR16WT51	535	300	600		
WVDP						
Subtotal		585	500	1000	TBD	TBD
ASTD						
CMST						
NETL						
ESP						
International	HQ06T222	100	100	50		
Robotics						

Table 5.24. (contd)

	TTP#	FY01	FY02	FY03	FY04	FY05
University						
EM-50 TFA Total		685	600	1050	TBD	TBD

Selective Chemical Dissolution of Tank Heels to Improve Retrieval
(TFA Strategic Technical Response AA3S1; Work Package WT-05-01)

The solids heels in some tanks at Hanford and SRS are expected to include larger particles or agglomerated particles that will be difficult to remove using normal sluicing methods. In some cases, these solids may be significantly different in composition relative to solids from the precipitation of bulk components in the waste. The TFA is making a strategic investment to investigate chemical methods to dissolve solids, break up agglomerates, or reduce the particle size by some other method so that they can be more easily removed from the waste. Initial workscope for this task includes:

- Identification and evaluation of tank heel characteristics.
- Development of simulants to represent troublesome heel components.
- Laboratory testing of chemical methods to dissolve, break up, or reduce the size of heel particulates.

Table 5.25. Budget Profile: Selective Chemical Dissolution of Tank Heels to Improve Retrieval (TFA Technical Response AA3S1; Work Package WT-05-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS						
WVDP						
Subtotal					TBD	TBD
ASTD						
CMST						
NETL						
ESP		200	350			
International						
Robotics						
University						
EM-50 TFA Total		200	350		TBD	TBD

Saltcake Dissolution Retrieval
(TFA Technical Response A9362; Work Package WT-02-01)

The Low-Volume Density Gradient (LVDG) retrieval method has been proposed as a less costly system for SST saltcake retrieval at Hanford. By placement of a single or multiple sprinklers through a riser into a SST, water can be added to the tank, allowing the saltcake to dissolve. As the dissolution proceeds, a transfer pump can transfer the dissolved salt out of the tank and into a feed staging tank. This method appears to be significantly less expensive and less complex than past practice sluicing for saltcake retrieval. Performance data and retrieval efficiency data are needed and the impacts to in-tank hardware and tank walls need to be determined. The chemistry involved in this process is addressed in Problem Element 1.2.2.3, "Prepare Retrieved Waste for Transfer and Pretreatment." Workscope to complete this activity includes:

- Conduct pilot-scale testing of a LVDG concept to evaluate the process and determine tank impacts (FY01, Hanford, TFA, SRS)
- Design and procure an LVDG system for full-scale demonstration (FY02, Hanford, TFA, SRS)
- Conduct an cold demonstration of a full-scale LVDG system (FY02, Hanford, TFA, SRS)
- Design and procure an LVDG system for hot deployment (FY03, Hanford, TFA, SRS)
- Deploy an LVDG system at Hanford (FY04, Hanford, TFA, SRS) (S112 Tank)

In addition, methods are being sought to sluice salt/sludge tanks with arm-mounted local low water sluice (S-102 Tank).

Table 5.26. Budget Profile: Saltcake Dissolution Retrieval (TFA Technical Response A9362; Work Package WT-02-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL09WT22	400	500	1150	700	
INEEL						
ORR						
SRS	SR16WT51	25	25	25		
WVDP						
EM-50 TFA Total		425	525	1175		TBD

Retrieval from Potential Leaking Tasks
(TFA Strategic Technical Response AA3S2; Work Package WT-03-01)

Retrieval methods are needed for tanks that have the potential for leaking during retrieval operations. The TFA is making a strategic investment to identify, evaluate, and test technologies that could be used to retrieve wastes while minimizing the impact to the surrounding environment. Workscope to initiate this strategic task includes:

- Define functions and requirements for a retrieval system for potentially leaking tanks.
- Identify and evaluate possible technologies for waste retrieval from potential leaking tanks.
- Conduct tests of promising technologies for waste retrieval from potential leaking tanks.

Table 5.27. Budget Profile: Saltcake Dissolution Retrieval (TFA Technical Response A93S2; Work Package WT-03-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS						
WVDP						
EM-50 TFA Total		100	200			TBD

Dry Solid Waste Retrieval
(TFA Technical Response A9331; Work Package WT-02-01, unfunded)

Highly radioactive waste material is stored in seven Calcined Solids Storage Facilities (CSSFs) at INEEL. The calcine was in the form of granular solids or powder when it was sent to storage. Some calcine may have formed a cake, bridge or other agglomeration during storage. Systems are needed to retrieve the granular solids and any caked material from the storage bins and to transfer the materials to a processing facility for treatment and immobilization. Bin Set 1 requires access risers to be installed to enable performance of sampling and retrieval operations. Riser attachments and cutting methods must be designed and cold tested before hot deployment.

Preliminary investigations at INEEL have been conducted with EM-30 funds to identify requirements for retrieval of the calcine waste. Additional work is needed to identify and resolve open issues before designing a dry retrieval system for the INEEL calcine bins. Workscope to complete this activity includes:

- Provide a riser attachment and cutting method for Bin Set 1 to enable calcine sampling.
- Complete calcine sampling and characterization, including dislodging testing.
- Identify and evaluate commercial retrieval and transfer systems for dry retrieval.

Waste Retrieval from Confined Spaces
(TFA Technical Response AA303; Work Package WT-12-01, unfunded)

Type I, II, and III waste storage tanks at SRS are equipped with an annular space between the primary containment wall and the secondary containment wall. Waste has leaked into the tank annulus of several waste tanks. Prior to closing the tank, the waste in the annuli must be characterized and retrieved. Ventilation ductwork routed around the bottom of each annulus limits access to the annulus floor. In some cases, such as Tank 16, waste has leaked into the ductwork. Characterization and retrieval technologies must be developed for final disposition of these waste tanks.

The technical approach to the Tank 16 annulus, which will be considered as the lead activity for this problem, is to first find out the chemistry of the waste so that it can be determined whether chemical cleaning methods may be applicable. Possible mechanical systems will be evaluated for retrieval as an alternative to chemical retrieval. The objective is to show the relative value between expensive chemical retrieval and expensive remote mechanical retrieval. For example, if an arm-based system is considered, then issues related to the number of risers that would need to be installed have to be addressed. Functions and requirements need to be developed by SRS staff. Calls will be issued on the retrieval approaches as the technical direction becomes scoped out. Technologies developed by the D&D Focus Area and other industrial sources will be used as resources.

Problem Element 1.2.1.4 Transfer Waste

Problem Element 1.2.1.4 Description and Priority Site Needs

After retrieval operations, waste transfer is required to move the waste to storage, to provide supernate for use in a retrieval operation, or to stage waste 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. 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 or, if plugging can't be avoided, to mitigate the plugged lines. The site needs addressed in this problem element are identified below in Table 5.28.

Table 5.28. Problem Element 1.2.1.4. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT023	Prediction of Solid Phase Formation in Static and Dynamic Hanford Waste Solutions	RL-TW04	Pipeline Unplugging	2367
RL-WT062	Variable Suction Level Transfer Pump	RL-TW04	Waste Transfer Pumping	
RL-WT040-S	Mechanisms of Line Plugging	RL-TW04		
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-HL04	Waste Transfer Pumping	2367
SR00-2039	Methods to Unplug Waste Transfer Lines	SR-HL01, SR-HL02, SR-HL04	Pipeline Unplugging	2367
ID-2.1.67	High Level Waste Slurry Handling	ID-HLW-103	Waste Transfer Pumping	

Problem Element 1.2.1.4 Technical Tasks

Pipeline Unplugging
(TFA Technical Response A9376; Work Package WT-01-01)

As the tank cleanout and decommissioning program becomes active at SRS, an increasing potential exists that current transfer lines will become plugged (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 reactions resulting in precipitation or crystallization. Safe and cost-effective mechanical pipeline unplugging systems are needed to mitigate future problems. Chemical methods for pipeline unplugging are being investigated as described in Problem Element 1.2.2.3, "Prepare Retrieved Waste for Transfer and Pretreatment."

Pipeline unplugging is important to SRS and Hanford. Three key issues will be examined with regard to transfer line blockages. First, there needs to be an understanding of the factors that contribute to line blockage. Identifying these factors will enable the implementation of programs and processes to help prevent 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 to the pipe. 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 site needs for pipeline unplugging will include

- Identify chemical and physical parameters that influence pipeline plugging.
  - Complete tests using waste simulants to determine minimum settling velocity for particles, erosion factors, and the potential for precipitation and adherence of waste to pipe walls during transport (FY01, TFA, University Programs).
  - Test gelation plugging and other effects of gelation on transfer conditions (FY02, FY03, TFA, University Programs).

- Demonstrate blockage location tools.
  - Select industrial partners to provide and demonstrate tools to locate and/or evaluate transfer line blockages (FY01, TFA, EM-50 University Programs).
  - Develop and test transfer line blockage location tools (FY01, TFA, EM-50 University Programs).
  - Demonstrate developed technologies for locating blockage and evaluate performance using simulants (FY03, TFA, EM-50 University Programs). **Decision point for demonstration.**

- Demonstrate blockage removal tools.
  - Select industrial partners to provide and demonstrate tools to remove blockages from transfer lines (FY01, TFA, EM-50 University Programs).
  - Develop and test transfer line blockage removal tools (FY02, TFA, EM-50 University Programs).
  - Demonstrate developed technologies for removing pipeline blockages and evaluate performance using simulants (FY03, TFA, EM-50 University Programs). **Decision point for demonstration.**
  - Conduct hot demonstration of pipeline unplugging equipment. (FY02, TFA, SRS)

Table 5.29. Budget Profile: Pipeline Unplugging (TFA Technical Response A9376; Work Package WT-01-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL36WT51 RL09WT21 RL09WT22	150 200 125	50			
INEEL						
ORR						
SRS	SRI6WT51	50	50	425		
WVDP						
Subtotal		525	100	425	TBD	TBD

Table 5.29. (contd)

	TTP#	FY01	FY02	FY03	FY04	FY05
ASTD						
CMST						
NETL						
ESP						
International						
Robotics						
University		1050	450	500		
EM-50 TFA Total		1575	550	925	TBD	TBD

Waste Transfer Pumping
(TFA Technical Response A9365; Work Package WT-02-01)

Transfer pumps are used to move supernate, sludge, slurry, and resins from storage tanks to treatment facilities and other storage facilities. These transfers typically occur through piping that could become plugged or that may not be immediately available. SRS needs an improved telescoping transfer pump that will improve pumping effectiveness to reduce the residual heel volume. Hanford needs a transfer pump that can withstand the forces of operating mixer pumps to ensure feed delivery meets specifications and that can pump only supernate when required. INEEL is selecting their HLW treatment processes and will need information to select and size their slurry handing equipment.

Existing transfer paths from the old style SRS tanks are complicated and require dedicated, intensive operations support. Additionally, these decades-old transfer lines require significant, costly refurbishment to achieve compliance with current DOE and regulatory requirements for sludge transfers. In fact, transfer line upgrades in many cases are cost prohibitive. Therefore, new temporary waste-transfer system designs that can be installed above ground, bypassing failed or suspect lines, that meet today's requirements (double-containment, leak detection, shielding, NPH (natural phenomena hazards [e.g., earthquakes] protection, etc.) are needed to support heel-removal operations.

To address these needs, the TFA is developing improved variable-depth transfer pumps to meet the transfer pumping requirements at SRS and Hanford, and is developing a temporary, above-ground, disposable transfer line for applications where pipelines are nonexistent or plugged. Workscope includes:

<u>Variable-Depth Transfer Pump</u>

- Conduct feature tests on candidate variable-depth transfer pump designs (FY01, Hanford, SRS)
- Issue final functions and requirements for variable-depth transfer pump (FY01, Hanford, SRS)
- Prepare final specifications for procurement of variable-depth transfer pump (FY02, SRS)
- Conduct cold testing of variable-depth transfer pump (FY03, SRS)
- Deploy variable-depth transfer pump (FY04, SRS)

Temporary Transfer Line

- Develop technical basis for decision to proceed with temporary transfer line (FY01, SRS)
- Procure temporary transfer line for application at SRS (FY01, SRS)
- Deploy temporary transfer line (FY02, SRS)

INEEL Slurry Transfers

- Conduct cold mockup tests to determine capabilities of the existing waste transfer system (FY01, INEEL)
- Determine functions and requirements for the INEEL waste transfer system (FY02, FY03, INEEL)

Table 5.30. Budget Profile: Waste Transfer Pumping (TFA Technical Response A9365; Work Package WT-02-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL09WT22 RL36WT51	25 250				
INEEL	ID70WT21	150	100	150		
ORR						
SRS	SR16WT51	450	650	400		
WVDP						
EM-50 TFA Total		875	750	550	TBD	TBD

Problem Element 1.2.1.5 Detect and Mitigate Leaks

Problem Element 1.2.1.5 Description and Priority Site Needs

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 drywells, 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. The site needs addressed in this problem element are identified below in Table 5.31.

Table 5.31. Problem Element 1.2.1.5. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT026	Tank Leak Detection Systems for Underground Single-Shell Storage Tanks	RL-TW03	Leak Detection	N/A
RL-WT027	Tank Leak Mitigation Systems	RL-TW03	Leak Mitigation, and Repair	N/A
RL-WT037	Tank Heel Removal/Closure Technology	SR-HL01 SR-HL02 SR-HL03	Leak Mitigation, and Repair	

Problem Element 1.2.1.5 Technical Tasks

Tank Leak Mitigation
(TFA Technical Response A9157; Work Package WT-03-01)

Leak mitigation systems that improve on 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 alternative evaluations of new mitigating technologies determine that deployment, implementation, and operation are feasible, then further evaluation should be pursued. Such evaluations may include demonstrations and testing. Example concepts that could be evaluated include retrieval methods that 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. Workscope to address the need leak mitigation and repair systems includes:

- Identify and evaluate leak mitigation and repair systems.
  - Define functions and requirements for leak mitigation and repair systems at Hanford and SRS (FY01, Hanford, SRS)
  - Identify and evaluate existing technolgies for Tank leak mitigation and repair (FY01, TFA)

- Develop and demonstrate tank leak mitigation and repair systems (FY02, TFA, TBD).
- Conduct hot demonstration of leak detection systems (FY03, TFA, TBD).

Table 5.32. Budget Profile: Leak Detection, Mitigation, and Repair (TFA Technical Response A9157; Work Package WT-03-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL00WT21 RL08WT21	300 100				
INEEL						
ORR						
SRS	SR18WT21	100				
WVDP						
EM-50 TFA Total		500	TBD	TBD	TBD	TBD

Leak Detection
(TFA Technical Response A9156; Work Package WT-12-01, unfunded)

The use of past-practice sluicing for removing waste from Hanford's SSTs involves adding liquid to tanks, therefore increasing the potential for waste leakage to the environment. Leak detection methods are needed that can signal and quantify a leak from a tank and can be incorporated into design features of retrieval systems and provide capability for the appropriate mitigation actions. Detection systems that improve on the capabilities of the current baseline approach (leak sensitivity is estimated to be about 8000 gallons) are needed. The objective is to detect a minimum quantity of liquid escaping in real time so that appropriate risk-base monitoring and/or mitigation measures can be implemented. Workscope to address the need for leak detection includes

- Identify and evaluate leak detection systems
  - Define functions and requirements for leak detection system.
  - Review and evaluate current leak detection systems available through industry, the DOE complex, universities, and under development.
  - Develop and demonstrate tank leak detection system.
  - Conduct hot demonstration of leak detection system.

Problem Element 1.2.2.2 Dissolve Waste

Problem Element 1.2.2.2 Description and Priority Site Needs

Calcination was the baseline technology at INEEL for solidifying liquid HLW and storing it as a granular solid in underground stainless steel bins. This problem element addresses development of methods to dissolve currently stored calcine to support future radionuclide separations that are an option for waste processing at the INEEL. The site needs addressed in this problem element are shown below in Table 5.33.

Table 5.33. Problem Element 1.2.2.2. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ID-2.1.51	Develop Calcine Dissolution Kinetics for Solid/Liquid Equilibria	ID-HLW-103	Calcine Dissolution	881
ID-2.1.52	Characterization of Solids from Calcine Dissolution	ID-HLW-103	Calcine Dissolution	881

Problem Element 1.2.2.2 Technical Tasks

Calcine Dissolution
(TFA Technical Response A9532; Work Package WT-11-01, unfunded)

The waste processing option for INEEL HLW calcine includes a separations flowsheet option and requires dissolution of calcine before radionuclide separation. Calcine must be dissolved to 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 of a treatment plant.

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 and actual calcine waste.
  - Expand on existing AEAT work to model calcine dissolution.

- 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.

Problem Element 1.2.2.3 Prepare Retrieved Waste for Transfer and Pretreatment

Problem Element 1.2.2.3 Description and Priority Site Needs

Waste transfers and pretreatment facilities require feed streams that can be transferred without plugging pipelines and are compatible with pretreatment unit operations (e.g., density, solids content, rheology, particle size, blending reactions, chemistry). Physical and chemical properties of tank waste can impact the efficiency of pretreatment processes. Various chemical combinations can lead to gelation or precipitation, which will adversely impact waste transfers and processing. A better understanding of sludge and saltcake chemistry and its impact on dissolution rates, pipeline transfers, and mixing operations is needed. This interface with retrieval and transfer focuses on understanding the effects of properties on waste transfer and pretreatment process efficiency. This understanding will ensure selection of appropriate operating parameters and performance requirements during retrieval, conditioning, transfer, and storage of wastes. The site needs addressed in this problem element are identified below in Table 5.34Table 5..

Table 5.34. Problem Element 1.2.2.3 Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT023	Prediction of Solid Phase Formation in Static and Dynamic Hanford Tank Waste Solution	RL-TW04	Tank Waste Chemistry and Dynamics	233, 1989, 2096, 2367
RL-WT040-S	Mechanisms of Line Plugging	RL-TW04		
RL-WT049-S	Effect of Processing on Gas Release, Waste Sedimentation, Rheological and Other Behaviors	RL-TW04	Related EMSP Project 54628	
RL-WT063	Retrieval and Closure – Hanford SST Saltcake Dissolution Retrieval	RL-TW04	Tank Waste Chemistry and Dynamics	1989, 2096
RL-WT071	Provide Laboratory Development Support and ESP Modeling Support for the Back Dilution of Tank 241-SY-101	RL-TW03	Tank Waste Chemistry and Dynamics	
RL-WT075-S	HLW Solid Phase Characterization	RL-TW01		
RL-WT078-S	Plutonium Segregation and Association in HLW	RL-TW04		
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-HL03	Tank Waste Chemistry and Dynamics	

Table 5.34. (contd)

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
SR00-2039	Methods to Unplug Waste Transfer Lines	SR-HL01, SR-HL02, SR-HL03	Tank Waste Chemistry and Dynamics	233, 2096, 2367
OR-TK-04	Sludge Mixing and Slurry Transport	OR-321	Tank Waste Chemistry and Dynamics	233, 2096, 2367

Problem Element 1.2.2.3 Technical Tasks

HLW Tank Waste Chemistry
(TFA Technical Response A9554; Work Package WT-08-01)

Unwanted solid formations have interrupted waste transfers at Hanford and waste processing at SRS. The Hanford concern is with the formation of pipeline plugs, while the formation of aluminosilicates in the evaporator system is the immediate concern at SRS. Understanding the phenomena of line plugging and scale buildup associated with waste retrieval, transfer, and treatment is needed to define operating conditions for these activities and to identify methods for pipe plug recovery. This work provides the chemical and thermochemical understanding of pipeline plugging and is closely related to work in Problem Element 1.2.1.4, "Transfer Waste," in which methods to unplug pipelines are being developed.

At Hanford, saltcake will be retrieved for subsequent treatment and immobilization. The baseline approach for retrieval of saltcake involves aqueous dissolution. Two saltcake retrieval processes, past-practice sluicing and low-volume density gradient, are currently under consideration. The chemistry of the dissolved saltcake is expected to be very complex and the dilution of dissolved saltcake can lead to additional solids formation such that the wastes would not meet feed specifications. The chemistry of saltcake dissolution is studied here, while the retrieval processes are described in Problem Element 1.2.1.2, "Mobilize Bulk and Heel Wastes."

The TFA is conducting an integrated program that includes work on solids formation, waste transport chemistry, sludge settling, and saltcake dissolution designed to solve this complex problem. The overall program includes the following activities; 1) prediction of solids formation from ionic waste solutions, 2) measurement and prediction of the viscosity of waste solution and slurries, 3) measurement of the kinetics of precipitation and measurement of precipitate properties, 4) development of chemical methods to remove pipeline plugs, 5) pilot-scale tests of slurry transfers and saltwell pumping, 6) development of slurry transport and saltwell pumping models, 7) measurement of the properties of settling sludge suspensions, 8) lab dissolution testing with actual saltcake, and 9) ESP code development and validation. The EMSP has funded a related project, "Colloidal Agglomerates in Tank Sludge. Impact on Waste Processing" (54628). The TFA is monitoring the progress of this project for application to the program.

Workscope to address these needs include:

- Determine the effects of temperature change, heat-transfer rate, supersaturation, and sheer rate on kinetics and properties of solids formation for Hanford wastes (FY01-FY02, Hanford, TFA, International Programs).
- Provide final recommendations for operating envelopes for Hanford waste transfers (FY01, Hanford, TFA).
- Determine the kinetics of formation of aluminosilicate and sodium diuranate in SRS evaporator system (FY01, SRS, TFA).
- Determine the effects of recycle on aluminosilicate formation (FY02, SRS, TFA).
- Complete laboratory studies of chemical methods to remove pipeline plugs at Hanford and SRS (FY01-FY02, Hanford, SRS, TFA).
- Complete pilot-scale pipe loop tests of chemical methods for pipeline unplugging (FY01-FY02, Hanford, SRS, TFA, University Programs).
- Provide data and models on waste stability during transport (FY01-FY02, TFA, University Programs).
- Develop and demonstrate engineering tools to predict the stability of Hanford waste feeds during slurry transport and saltwell pumping (FY01-FY02, Hanford, TFA).
- Provide final recommendations for operating envelopes for SRS waste transfers (FY02).
- Complete dissolution tests on selected actual Hanford saltcake samples (FY01, Hanford, TFA).
- Determine radionuclide partitioning during saltcake dissolution testing (FY01-FY02, Hanford, TFA).
- Modify ESP code to include Pitzer parameters based on EMSP funded work in project "Chemical Speciation of Strontium, Americium, and Curium in High-Level Waste. Predictive Modeling of Phase Partitioning During Tank Processing" (54621).
- Complete benchmarking and validation of ESP code for Hanford saltcake wastes (FY01).

Table 5.35. Budget Profile: Prevention of Solids Formation (TFA Technical Response A9554; Work Package WT-08-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL09WT32	250				
	RL08WT41	550	250			
	RL36WT41	250	200	200		
INEEL						
ORR	OR16WT41	875	750			
SRS	SR19WT31	125	125			
WVDP						
Subtotal		2050	1325	200	TBD	TBD
ASTD						
CMST						
NETL						
ESP						
International	HQ06PS11	125	125			
Robotics						
University	FT07IP02	850	700			
EM-50 TFA Total		3025	2450	200	TBD	TBD

Problem Element 1.2.2.4 Clarify Liquid Stream

Problem Element 1.2.2.4 Description and Priority Site Needs

Liquid wastes retrieved from storage tanks require clarification (i.e., filtration, centrifuging, decanting) to remove suspended solids, such as sludges or precipitates, that may interfere with downstream processing. The site need addressed by this problem element is addressed below in Table 5.36Table 5..

Table 5.36. Problem Element 1.2.2.4. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ID-2.1.64	Solid-Liquid Separation Equipment Development and Application	ID-HLW-103	Solid Liquid Separations	350

Problem Element 1.2.2.4 Technical Tasks

Solid/Liquid Separations
(TFA Technical Response A9584; Work Package WT-08-01)

INEEL is developing their flowsheet for treatment of tank wastes and anticipates that solid/liquid separations will be included in the waste treatment process. Due to physical and chemical variations of the undissolved solids in the INEEL wastes and the lack of solids characterization data, additional testing of solid/liquid separations is needed to define operating conditions and performance limitations. Amenable filtration technologies must ultimately be tested with actual concentrated INEEL tank wastes.

The Cells Unit Filter (CUF) crossflow filtration unit will be used to obtain solid/liquid separations data.

Workscope to address this need includes:

- Reassemble CUF crossflow filtration equipment installation in INTEC hot cells (FY01, INEEL, TFA).
- Perform solid/liquid separations testing with CUF and surrogate and concentrated tank wastes and heels (FY01, INEEL, TFA).
- Conduct solid/liquid separations pilot-scale testing using selected separations method (FY02, INEEL, TFA).

Table 5.37. Budget Profile: Solid Liquid Separations (TFA Technical Response A9584; Work Package WT-08-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL	ID70WT32	300	500			
ORR						
SRS						
WVDP						
EM-50 TFA Total		300	500	TBD	TBD	TBD

Problem Element 1.2.2.5 Remove Radionuclides

Problem Element 1.2.2.5 Description and Priority Site Needs

Radionuclide removal from tank waste supernate and dissolved wastes is a primary requirement at all the DOE waste tank sites. This is because the presence of radionuclides directly impacts waste immobilization decisions and the volume and cost of low-level and high-level wastes generated. The primary radionuclides of concern are cesium (Cs), strontium (Sr), technetium (Tc), and transuranic elements (TRUs). 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. The site needs addressed in this problem element are identified below in Table 5.38.

Table 5.38. Problem Element 1.2.2.4. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT082	Crystalline Silicotitanate Non-Elutable Sorbent	RL-TW05	Alternatives to In-Tank Precipitation	21, 2009
SR00-2034	Second Generation Salt Feed Preparation	SR-HL13		
SR00-2053-S	Develop and Alternative Sorbent to Replace Monosodium Titanate for Sr and Actinide Removal	SR-HL01 SR-HL02	Related EMSP Projects 54735, 60345	
ID-2.1.06	TRU, Cs, and Sr Removal from High Activity Wastes	ID-HLW-103	Solvent Extraction Processes for Dissolved Calcine	21, 347, 2096
ID-2.1.28	Cs and Sr Removal from Newly Generated Liquid Waste	ID-HLW-103	Cesium Removal Using Crystalline Silicotitianate	21
ID-2.1.56	Mercury Treatment for Aluminum Calcine	ID-HLW-103	Solvent Extraction Processes for Dissolved Calcine	
ID-2.1.68	Technetium Removal from INEEL High Level Waste	ID-HLW-101	Solvent Extraction Processes for Dissolved Calcine	
OR-TK-11	ORNL Tank Supernatant Pretreatment	OR-311	Modular Evaporator Ion Exchange System	20, 21, 2096

Problem Element 1.2.2.5 Technical Tasks

Solvent Extraction Processes for Dissolved Calcine
(TFA Technical Response A9501; Work Package WT-09-01)

Separation of key radionuclides from dissolved calcine is being investigated to support selecting a preferred treatment option for INEEL's calcined HLW. Alternative radionuclide separations methods are being investigated to provide data required to develop technology roadmaps and recommendations for the INEEL HLW EIS Record of Decision for calcine treatment and disposal.

The removal of Cs and other radionuclides may be accomplished via solvent extraction technology, which has been under development by the DOE-EM programs for over ten years. The TRUEX process, for TRU component removal, will be developed to provide working flowsheets for demonstration and implementation in centrifugal contactor equipment. An alternative and promising approach to using two discrete unit operations to remove Cs and actinides is the UNEX process, which has been demonstrated to effectively remove these radionuclides as well as Sr from actual tank waste down to Class A LLW levels. This chemistry and flowsheet design also needs to be developed and demonstrated, as well as verified with actual concentrated waste feed streams.

Workscope to address this need includes:

- Conduct radioactive tests with dissolved calcine to demonstrate Cs, Sr, and TRU separations using individual solvent extraction processes (FY01, INEEL, TFA).
- Develop UNEX process for removal of Cs, Sr, and TRU (FY01, INEEL, Khlopin Radium Institute, TFA).

Table 5.39. Budget Profile: Solvent Extraction Processes for Dissolved Calcine
(TFA Technical Response A9501; Work Package WT-09-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL	ID70WT32	350	TBD			
ORR						
SRS						
WVDP						
Subtotal		350	TBD	TBD	TBD	TBD
ASTD						
CMST						
NETL						
ESP						
International	HQ06T222	150	150			
Robotics						
University						
EM-50 TFA Total		500	TBD	TBD	TBD	TBD

Salt Processing Project Technical Research and Development
(TFA Technical Response A9570; Work Package WT-09-01)

The Department of Energy's (DOE) Savannah River Site (SRS) high-level waste (HLW) program is responsible for storage, treatment (separation) and vitrification of HLW for disposal. The Salt Processing Project (SPP) is the salt waste treatment portion of the HLW cleanup effort. The overall SPP encompasses the selection, design, construction and operation of effective treatment technologies to prepare the salt waste feed material for the site's Saltstone facility and vitrification facility (Defense Waste Processing Facility, [DWPF]). Major constituents that must be separated and sent as feed to DWPF include actinides, strontium, and cesium.

Due to technical, production, and safety issues, the baseline technology for salt processing was suspended in 1998 and efforts shifted to identification of alternative separation technologies. Based on rigorous identification and screening of alternatives, several technical options were selected for further consideration. Testing activities were pursued in 1998 and 1999 to support downselect and pre-conceptual design of a preferred option. However, the results of testing along with several independent reviews (including the National Academy of Sciences [NAS]) concluded that additional research and development (R&D) is required for all technical options before an appropriate downselection can be made.

The TFA is supporting the EM-40 led Technical Working Group by providing direct oversight and management of the research and development associated with the SPP. The SPP/research and development focuses on activities related to conducting the necessary research and development for four primary technology alternatives that separate selected radionuclides from HLW prior to vitrification.

Three technology alternatives currently being pursued to remove cesium include:

1. Small Tank Tetraphenylborate Precipitation (STTP)
2. Non-Elutable Ion Exchange Using Crystalline Silicotitanate (CST)
3. Caustic Side Solvent Extraction (CSEX)

In addition, alpha removal technology is also being investigated as part of the overall salt processing flowsheet development.

The scope of the SPP/research and development is to conduct the development and testing necessary to reduce the technical uncertainties of each separation technology to enable a downselection to be made and support follow-on design and scale-up.

Workscope to be conducted in FY01 includes:

<u>Cesium Separations Using Non-Elutable Ion Exchange Using Crystalline Silicotitanate (CST)</u>

- Determine long-term thermal and chemical stability of CST and impact on performance (FY01, SRS, TFA).
- Develop and demonstrate solution to column plugging during CST pretreatment and during extended column operation (FY01, SRS, TFA).

- Collaborate with the vendor to optimize CST or pretreatment process to mitigate solids formation (FY01, SRS).
- Recommend operability regime for CSTs (FY01, SRS, TFA).
- The EMSP has funded a related project "New Silicotitanate Waste Forms. Development and Characterization" (60345).

Cesium Separations using Small Tank Tetraphenylborate (TPB) Precipitation

- Verify TPB decomposition process using both simulant and real waste in bench-scale CSTR (FY01, SRS, TFA).
- Develop fundamental understanding of TPB decomposition chemistry, including key catalysts (FY01, SRS).

Cesium Separations using Caustic Side Solvent Extraction

- Determine radiation stability of alternative solvents and impact on performance (FY01, SRS, TFA).
- Determine partitioning of organic and inorganic waste components in extractant (FY01, SRS, TFA).
- Determine performance of extractant with respect to variations in waste composition (FY01, SRS, TFA).
- Commercialize production of extractant (FY01, SRS, TFA, ORNL).
- Determine impacts of solution composition and suspended solids on contactor performance (FY01, SRS, TFA).
- Demonstrate with 2-cm contactors, using both simulant and real waste, the current flowsheet over extended solvent recycle (FY01, SRS, TFA).
- Demonstrate solvent recovery from aqueous raffinate (FY01, SRS, TFA).
- The EMSP has funded a related project "Design and Synthesis of the Next Generation of Crown Ethers for Waste Separations. An Inter-Laboratory Comprehensive Proposal" (55087).

Strontium and Actinide Separations for SRS

- Evaluate alternatives to monosodium titanate (MST) as a sorbent for Sr and actinide removal (FY01, SRS, TFA).
- Test MST filtration at pilot-scale (FY01, SRS).
- Develop prototype for on-line monitoring of cesium, alpha, and strontium analysis (FY01, SRS).
- Develop fundamental understanding of actinide sorption by MST, e.g., Pu collodial and Pu speciation (FY01, SRS).
- Evaluate centrifugation, vibratory enhanced cross-flow filtration, and dead-end filtration for solid/liquid separations (FY01, SRS, TFA).
- Evaluate chemical additives to improve solid/liquid separations (FY01, SRS, TFA).
- Evaluate settling as a solid/liquid separations approach (FY01, SRS, TFA).

Table 5.40. Budget Profile: Salt Processing Project Technical Research and Development (TFA Technical Response A9570; Work Package WT-09-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL31WT21 RL09WT32	800 752				
INEEL						
ORR	OR01WT21 OR01WT22	2130 1788				
SRS	SR01WT21	960				
WVDP						
ANL	CH21WT21	850				
SNL	AL21WT21	340				
EM-50 TFA Total		7620	7800	TBD	TBD	TBD

Problem Element 1.2.2.6 Integrate Pretreatment and Immobilization Technology Systems

Problem Element 1.2.2.6 Description and Priority Site Needs

Pretreatment and immobilization systems are intimately related because the chemistry and performance requirements of one system directly impacts the other. This problem element provides the understanding and tools necessary to integrate the pretreatment and immobilization processes.

Table 5.41. Problem Element 1.2.2.6. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
SR00-2055	Increase in Applicability/Efficiency of High-Level Waste Planning Tool	SR-HL05	Integration/Optimization of High Activity/Low Activity Waste Process Flowsheet	
ID-2.1.24	Integration/Optimization of High Activity/Low Activity Waste Process Flowsheet	ID-HLW-103	Integration/Optimization of High Activity/Low Activity Waste Process Flowsheet	
ID-2.1.24	Treatment/Disposition of Removed Tank Solids	ID-HLW-103	Integration/Optimization of High Activity/Low Activity Waste Process Flowsheet	

Problem Element 1.2.2.6 Technical Tasks

Integration/Optimization of High-Activity/Low-Activity Waste Process Flowsheet
(TFA Technical Response A9709; Work Package WT-06-01)

Many alternatives and options are being considered for the treatment and qualification of radioactive wastes located at INTEC for permanent disposal. Adequate evaluation of these options requires that each one have a process flow diagram and associated mass and energy balances. The flowsheet provides the technical basis for performing process definition cost estimates, safety evaluations, and estimates of impact to the environment. Later, they provide the technical bases for facility design and operating permit applications. The existing flowsheet development tools, both mathematical models and software, need to be integrated into a single simulation model to perform these calculations automatically, with minimal effort on the part of the engineer(s) who are tasked with doing this work. This integrated model will provide more process performance information required for further evaluations.

At SRS, DuPont's Chemical Process Evaluation System (CPES), its associated chemical database, and the DWPF's Product Composition Control System (PCCS) are used to support HLW system planning efforts and perform flowsheet evaluations. An efficient flowsheet tool is still needed during HLW process operation to support evaluation of waste tank blending scenarios (including evaluation of salt disposition options), identify process and cost improvements, and generate necessary data for regulatory

and other needs. Conversion of the CPES to a vendor supported, industry standard simulation program and the addition of PCCS functionality will increase the efficiency of planning calculations, ensure long term software support, and provide a program that will be widely supported at SRS and across the DOE complex.

Workscope to complete this activity includes:

- Complete the software QA Plan, Software Requirements Specification, Process Options Description, and Software Design Document (FY01, TFA, INEEL, SRS).
- Complete an integrated steady-state flowsheet for the selected processing option (FY01, TFA, INEEL).
- Update the Software Requirements Specification, Process Options Description, and Software Design Document to include the downselected process option and dynamic process simulation (FY02, TFA, INEEL, SRS).
- Complete dynamic integrated flowsheets and update steady-state integrated process flowsheets (FY03, FY04, TFA, INEEL, SRS).

Table 5.42. Budget Profile: Integration/Optimization of High Activity/Low Activity Waste Process Flowsheet (TFA Technical Response A9709; Work Package WT-06-01)

	TTP#	**FY01**	**FY02**	**FY03**	**FY04**	**FY05**
Hanford						
INEEL	ID77WT31	280	150	290		
ORR						
SRS	SR16WT31	260	170	410		
WVDP						
EM-50 TFA Total		540	320	700	TBD	TBD

Problem Element 1.2.2.7 Process Sludge

Problem Element 1.2.2.7 Description and Priority Site Needs

Sludge waste requires processing to remove entrained radionuclides for downstream separation and processing, and to remove salts and minerals that may impact downstream vitrification. Sludges at SRS, Hanford, and ORR will require processing to remove nonradioactive constituents (e.g., aluminum, chromium, technetium, or phosphate) that either add to the volume of immobilized HLW or impact immobilization processing. Sludge processing primarily involves washing and separations. The site needs addressed in this problem element are identified below in Table 5.43.

Table 5.43. Problem Element 1.2.2.7. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ORTK-05	Tank Sludge and Supernatant Separations	OR-151 OR-311	Sludge Processing Studies	
RL-WT024	Enhanced Sludge Washing Process Data	RL-TW04	Sludge Processing Studies	233, 2096, 2236
RL-WT037-S	Sludge Treatment	RL-TW04	Related Relevant EMSP Projects 54765, 54773, 60403, 65368, 65411	
RL-WT038-S	Process Models for Sludge Treatment	RL-TW04	Related Relevant EMSP Project 59982	
RL-WT078-S	Plutonium segregation and Association in HLW	RL-TW04		
RL-WT070	Uncertainty Estimation of Hanford Best Basis Toxic Waste Inventory, Concentration, Phase and Waste Type	RL-TW01	Sludge Processing Studies	
SR00-2052	Aluminum Dissolution from HAW Sludge and Its Impact on Downstream	SR-HL02 SR-HL05	Sludge Processing Studies	

Problem Element 1.2.2.7 Technical Tasks

Sludge Processing Studies
(TFA Technical Response A9555; Work Package WT-08-01)

To reduce the volume and, thus, the cost of treating HLW from tanks at Hanford and SRS, it will be necessary to leach or wash as much of the bulk sodium and aluminum from the waste solids (sludges) as possible. Some Hanford tanks contain significant quantities of materials such as phosphate and chromium that, at high concentrations, can severely affect the production or quality of the vitrified HLW. In those cases, it will be necessary to leach the phosphate and/or chromium from the sludges or increase

the volume of glass (by diluting those components sufficiently to maintain acceptable glass properties). The baseline sludge treatment process at Hanford is Enhanced Sludge Washing (ESW), which involves a series of inhibited water washes, and caustic leaches to remove water-soluble salts, aluminum, and key components such as phosphate and chromium.

At SRS, aluminum in the tank sludges has been observed to transform from a more readily dissolved form of aluminum hydroxide (Gibbsite) to a less readily dissolved form (Boehmite). The SRS sludges need to be characterized with respect to the form of aluminum and impacts on dissolution performance.

Tanks T1 and T2 at ORR are 5,000-gal stainless steel, horizontal tanks. The High Flux Isotope Reactor (HFIR) tank is a slightly larger concrete tank. These three tanks contain approximately 8,000 gal of resin beads and sludge resulting from the neutralization of liquid waste previously stored in the tanks. The waste must be removed and treated for storage or disposal in 2001 in order to meet the site's Federal Facilities Compliance Agreement. The liquid waste can be treated in existing waste treatment facilities. However, the resin/sludge mixture does not meet waste acceptance criteria for existing facilities; it must be pretreated to remove the TRU components prior to future storage, treatment, or disposal.

The EMSP is funding several projects related to sludge processing studies. The TFA is monitoring the progress of these projects for application to the program. These projects include:

- Enhanced Sludge Processing of HLW. Hydrothermal Oxidation of Chromium, Technetium, and Complexants by Nitrate (54765)
- Microstructural Properties of High Level Waste Concentrates and Gels with Raman and Infrared Spectroscopies (54773)
- Phase Chemistry of Tank Sludge Residual Components (60403)
- Speciation, Dissolution, and Redox Reactions of Chromium Relevant to Pretreatment and Separation of High-Level Wastes (65368)
- Precipitation and Deposition of Aluminum-Containing Phases in Tank Waste (65411)
- Reactivity of Peroxynitrite for Hanford Waste Management and Remediation (59982)

Workscope to address the sludge processing needs includes:

<u>Hanford Sludge Washing Studies</u>

- Conduct parametric tests of caustic leaching with additional Hanford sludges (FY01-FY02, Hanford, ESP, TFA)
- Develop chemistry models and databases to quantitatively model the enhanced sludge washing process (FY01-FY02, University Programs, MSU/DIAL, TFA)
- Determine optimum process conditions for sludge washing of Hanford wastes (FY01-FY02, ESP, TFA)

<u>SRS Sludge Washing Studies</u>

- Characterize the aluminum form and dissolution performance for SRS tank waste sludges (FY01-FY02, SRS, ESP, TFA)
- Determine optimum process conditions for sludge processing of SRS waste sludges (FY01-FY02, ESP, TFA)

ORR T1, and T2 Sludge Treatment

- Conduct a parametric sludge treatment study with actual ORR tank waste samples to determine an appropriate treatment technique (FY01, ORR, TFA)

Table 5.44. Budget Profile: Sludge Processing Studies (TFA Technical Response A9555; Work Package WT-08-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL36WT41 RL08WT41 RL09WT32	150 100 465	100 100			
INEEL						
ORR	OR16WT41	35				
SRS	SR19WT31	150	100			
WVDP						
Subtotal		900	300	TBD	TBD	TBD
ASTD						
CMST						
NETL						
ESP	RL00C321	825	1800			
International						
Robotics						
University	FT07IP02	200	200			
EM-50 TFA Total		1925	2300	TBD	TBD	TBD

Removal of Key Non-Radioactive Elements from Tank Wastes
(TFA Strategic Technical Response AA5S1; Work Package WT-08-01)

HLW tanks across the DOE complex contain elements or components that are not radioactive and are present in only low to moderately low concentrations. However, these components present real or potential problems with further pretreatment or treatment of the wastes. Removal of abundant nonradioactive components is covered in the Enhanced Sludge Washing project (Technical Response A9555). Components that are difficult to handle in the glass melters are particular problems. Some example problem components are chromium, phosphate, sulfate, mercury, and noble metals. Typical HLW glasses can only contain limited concentrations of these elements, and the elements may require more extensive effluent treatment systems. These concentration limits can be met at all sites if the wastes from different tanks can be blended to an “average” waste composition, or by other blending procedures. Blending has its own costs and risks associated with the potential for pipeline plugging.

The TFA is making a strategic investment to identify and evaluate innovative methods for removing these key nonradioactive elements from the tank wastes as part of a pretreatment process. The focus of the work will be on removal of chromium, phosphate, and sulfate from alkaline sludges, and mercury from alkaline sludges and scrubber solutions. The workscope to be conducted includes testing with simulated and actual tank wastes and preparation of a conceptual flowsheet for the removal process(es).

Table 5.45. Budget Profile: Removal of Key Non-Radioactive Elements from Tank Wastes (TFA Technical Response AA5S1; Work Package WT-08-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS						
WVDP						
EM-50 TFA Total		250	250	TBD	TBD	TBD

Problem Element 1.2.3.1 Process LLW

Problem Element 1.2.3.1 Description and Priority Site Needs

The low-level waste (LLW) streams produced during pretreatment separation operations 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 onsite to off-site disposal. The site needs addressed in this problem element are identified below in Table 5.46.

Table 5.46. Problem Element 1.2.3.1. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ID-2.1.23	Low-Activity Wasteform Qualification	ID-HLW-103	Conditioning and Immobilization of Low-Activity Waste	21, 82, 2094, 2371
ID-2.1.28	Cs and Sr Removal from Newly Generated Liquid Waste	ID-HLW-103	Conditioning and Immobilization of Low-Activity Waste	21, 82, 2094, 2371
ID-2.1.35	Direct Immobilization of INTEC Sodium-Bearing and Newly Generated Liquid Waste	ID-HLW-103	Conditioning and Immobilization of Low-Activity Waste	21, 82, 2094, 2371
ID-2.1.38	Conditioning of Low Activity Wastes for Treatment	ID-HLW-103	Conditioning and Immobilization of Low-Activity Waste	21, 82, 2094, 2371
ID-2.1.40	Low Activity Waste Grout Sorbent Addition to Reduce Leachability	ID-HLW-103	Conditioning and Immobilization of Low-Activity Waste	21, 82, 2094, 2371
ID-2.1.66	Treatment/Disposition of Spent Ion Exchange Resins	ID-HLW-103	Conditioning and Immobilization of Low-Activity Waste	21, 82, 2094, 2371
OR-TK-06	Tank Sludge Supernatant Immobilization	OR-311 OR-151	Conditioning and Immobilization of Low-Activity Waste	21, 82, 2094, 2371

Problem Element 1.2.3.1 Technical Tasks

Conditioning and Immobilization of Low-Activity Waste
(TFA Technical Response A9719; Work Package WT-07-01)

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 Tank Waste Remediation System (TWRS) privatization contract. Glass waste forms are being considered for Hanford and have

been used for M Area sludges at SRS. At INEEL, high nitrate levels in LLW feed require development of an appropriate LLW grout formulation. At ORR and INEEL, work is needed to identify sorbents and stabilizers that will serve as binders or additives for retaining hazardous constituents and radionuclides in order to enhance the performance of the waste form. A sound basis for selecting LLW forms and the data needed to make this selection would help DOE evaluate proposals, support design decisions, and provide stakeholders with better information for considering waste form options.

Under a jointly funded EM-50 and EM-30 development effort, AEAT and INEEL prepared several grout formulations. This work provided candidate grout formulations for denitration and direct grouting of the LAW fractions.

Workscope to complete this activity includes:

- Evaluate sorbents and stabilizers to enhance performance of low-activity waste forms for INEEL and ORNL.
  - Conduct radioactive testing of potential sorbents and stabilizers using actual ORR wastes (FY01, FY02, TFA, ORNL).
  - Document identification and evaluation of sorbents and stabilizers to enhance performance of low-activity waste forms (FY02, TFA, ORNL).

- Develop grout formulations and process for immobilizing INEEL NGLW
  - Complete fabrication and installation of pilot-scale grouting plant (FY01, INEEL, TFA)
  - Conduct pilot-scale tests of grouting of INEEL NGLW (FY01-FY02, INEEL, TFA)
  - Conduct integrated waste treatment and grouting pilot-scale demonstrations (FY03, INEEL, TFA)
  - Complete fabrication and installation of waste treatment system for INEEL NGLW (FY03, INEEL, TFA)
  - Conduct radioactive demonstration of treatment and grouting of INEEL NGLW (FY04, INEEL, TFA)

Table 5.47. Budget Profile: Conditioning and Immobilization of Low-Activity Waste (TFA Technical Response A9719; Work Package WT-07-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL	ID77WT31	805	500	550	650	
ORR	OR10WT31	250	100			
SRS						
WVDP						
Subtotal		1055	600	550	650	TBD
ASTD						
CMST						
NETL						
ESP						
International	AEAT HQ06PS11	275	150	50		

Table 5.47. (contd)

	TTP#	FY01	FY02	FY03	FY04	FY05
Robotics						
University						
EM-50 TFA Total		1330	750	550	650	TBD

Problem Element 1.2.3.2 Process HLW

Problem Element 1.2.3.2 Description and Priority Site Needs

Immobilization of the HLW streams at INEEL, SRS, and Hanford is required to produce an acceptable HLW form for final disposal. Calcine immobilization and vitrification are the baseline methods for HLW immobilization. In addition to these baseline processes, this problem element addresses melter feed preparation, process monitoring, and process control methods to produce acceptable waste forms.

At all of the DOE radioactive waste tank sites, the baseline technology for HLW processing is vitrification (this process is operational at SRS and WVDP). At SRS, methods that can reduce the cost of operations are being identified and evaluated. Cost reduction can occur through optimization of waste loading that reduces the number of glass canisters produced, and through improvements in process equipment and materials of construction that minimize maintenance and downtime by reducing corrosion or other material failure problems. At the Hanford Site, optimized waste loading and melter selection are important considerations for developing a baseline to support waste processing, especially with regard to concerns about high Cr wastes and their compatibility with current melter designs and waste formulations. At INEEL, waste formulations for sodium-bearing waste and calcined wastes, followed by melter testing, are needed to meet an accelerated schedule for their ROD and Title 1 design schedule. Corrosion of melter materials from acidic wastes at the INEEL is a key issue that must be addressed with both waste formulation and materials development and testing. The site needs addressed in this problem element are identified below in Table 5.48.

Table 5.48. Problem Element 1.2.3.2. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT080	Advanced/Improved Vitrification	RL-TW05	Specify and Enhance Design and Operation of HLW Melters	
RL-WT081	Sulfate Accumulation in Low Activity Waste	RL-TW04	Improve Waste Loading in HLW Glass	
RL-WT084	Extension of Glass Properties Model to Lower Silica Compositions	RL-TW0	Improve Waste Loading in HLW Glass	
SR00-2032	Optimize Melter Glass Chemistry	SR-HL05	Improve Waste Loading in HLW Glass	2009
SR00-2036	Develop Improved HLW Melter	SR-HL05	Improve Performance and Design of HLW Melters	2009, 2092
ID-2.1.57	Conditioning of HAW for Treatment	ID-HLW-103	Improve Waste Loading and HLW Glass	2009, 2092

Table 5.48. (contd)

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ID-2.1.58	HAW Immobilization	ID-HLW-103	Specify and Enhance Design and Operation of HLW Melters	2009, 2092
ID-2.1.66	Treatment/Disposition of Spent Ion Exchange Resins	ID-HLW-103	Specify and Enhance Design and Operation of HLW Melters	

Problem Element 1.2.3.2 Technical Tasks

Improve Waste Loading in HLW Glass
(TFA Technical Response A9773; Work Package WT-06-01)

The DWPF at SRS complies with Waste Acceptance Product Specifications (WAPS) and process control requirements by demonstrating, to a high confidence, that melter feed will produce glass that meets all quality and processing requirements. This method requires that uncertainties associated with sampling, sample analysis, and models used to estimate properties are 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, leading to conservative waste loading. 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 uncertain). New or improved versions of existing property models for liquidus temperature and durability are needed, and model tolerances need to be identified. These models should be applicable to the entire range of plausible glass compositions.

In addition to liquidus issues at SRS, waste loading issues associated with Cr and glass phase separation have been identified at Hanford and SRS. 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 Cr minerals, spinels, and noble metals (e.g., Ru, Rh, Pd). An alternative method for handling problem constituents in HLW glasses is needed. The volume of HLW glass that will be produced from the Hanford sludges depends 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 staging strategy that provides adequate feed for treatment and immobilization. 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.

INEEL is developing a vitrification process for the immobilization of sodium bearing waste and for calcine waste. As part of that development, there is a need to determine glass-forming additives required to vitrify the HLW to a form that has physically and chemically acceptable properties for storage and disposal. An important input to both process selection and cost evaluation is achievable waste loading. This information will be used in the design of the vitrification process, including the processes to ensure the quality of the final glass waste form.

The EMSP is funding two projects that are related to improving waste loading in HLW glasses. The projects include "The Influence of Radiation and Multivalent Cation Additions on Phase Separation and Crystallization of Glass" (59827) and "Stability of High-Level Waste Forms" (60020). The TFA is monitoring the progress of these projects for application to the program.

Work activities to support needs for optimizing waste loading include:

- Address Liquidus Temperature and other Processing Issues
  - Implement liquidus temperature data into DWPF process models (FY01, SRS, TFA)
  - Evaluate alternatives to improve the melt rate and increase waste loading (FY02-FY03, SRS, TFA)
  - Expand the composition/property database to Hanford compositions of interest (FY01-FY03, SRS, Hanford, TFA)

- Evaluate Multiphase Glasses for the Development of Amorphous Phase Separation, Crystallization, and Impacts on Durability
  - Develop data necessary to improve models needed to restrict application of the current DWPF durability model (FY01-FY03, SRS, TFA)
  - Study the impact of crystalline phases on durability to provide a technical basis for restriction to single phase glasses or to allow for multiphase glasses (FY01-FY03, TFA)

- Develop Glass Formulations for INEEL Wastes
  - Develop glass formulations for direct vitrification of INEEL sodium-bearing waste (FY01-FY03, INEEL, TFA)
  - Develop glass formulations for INEEL calcines

Table 5.49. Budget Profile: Improve Waste Loading in HLW Glass
(TFA Technical Response A9773; Work Package WT-06-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL09WT31 RL37WT31	450 730	 500	 600		
INEEL	ID77WT31	400	500	500		
ORR						
SRS	SR16WT31	730	500	600		
WVDP						
EM-50 TFA Total		2310	1500	1700	TBD	TBD

Specify and Enhance Design and Operation of HLW Melters
(TFA Technical Response A9768; Work Package WT-06-01)

SRS's DWPF has been operating for a number of years, providing opportunities to identify improvements to the vitrification process design and glass melter design. INEEL is currently developing the processes for vitrification of their HLW. The work described here will provide the process and melter improvements for DWPF and support development of INEEL's vitrification process and melter.

The glass melter is one of the most expensive and most complicated components in the DWPF. Because of lower than anticipated melting rates and poor glass pouring performance, the melter has been the production rate limiting component in the plant. Although DWPF Melter-1 has exceeded its two-year design life expectancy, it is desirable to evaluate/improve its design life and performance by improving the pour spout and heater systems, and by developing enhancements to address processing of future feeds containing higher levels of noble metals. Accumulation of noble metals has been demonstrated to shorten the life of HLW glass melters in this country, as well as in Europe.

Changes to the configuration of the melter pour spout are required to stabilize glass pouring behavior. A phenomenon called "wicking" causes the glass to adhere to the wall of the pour spout rather than dropping directly into the canister. This has resulted in significant plugging of the pour spout and poor glass production rates. Current work is focused on the DWPF pouring issues related to pour spout configuration (knife edges, heater locations, temperature, etc.) to prevent the occurrence of wicking.

Melter feed chemistry is affected by feed conditioning. For DWPF, this includes the level of washing, composition of the Cs-bearing stream, levels of carbonate in-growth to the sludge, and the extent of REDOX adjustment that occurs in feed preparation. For INEEL, feed conditioning includes the extent of denitration occurring in pretreatment, chemical components added during pretreatment, and high Zr and other components that may be difficult to incorporate into the glass. Improvements in the feed chemistry (REDOX potential) can impact melting behavior and improve melt rates. This part of the need relates to both SRS and to INEEL and will be addressed jointly. At INEEL, conditioning of the HAW fraction of treated calcine is needed to reduce glass volume for expected interim storage/ transportation and to regulate the REDOX potential of the feed to the melter. Highly oxidized feeds such as INEEL's tends to foam in the melter and can result in operating problems similar to those being experienced at SRS. HAW immobilization requires pilot-scale operation of proposed feed streams for melt rate, compatibility, and general operability tests.

The EMSP is funding two projects, relevant to this work, on melter design and operational enhancements. These projects are "Millimeter-Wave Measurements of High-Level and Low Activity Glass Melts" (65435) and "Modeling of Spinel Settling in Waste Glass Melter (65422). The TFA is monitoring the progress of these projects for application to the program.

Work activities to support SRS and INEEL needs in melter throughput and design include:

<u>Pour Spout Testing</u>

- Test pour spout and insert design changes and confirm adequacy for DWPF Melter #2 (FY01-FY02, SRS, FIU, TFA).

Noble Metals Testing

- Determine the adequacy of mixing/stirring to mitigate noble metals and spinel deposition (FY01, SRS, TFA).
- Test design concepts to cope with noble metals (FY02-FY03, SRS, TFA).

Melt Feed Chemistry Enhancements

- Recommend controls for REDOX and anion concentrations to improve melting process (FY01-FY02, SRS, INEEL, TFA).
- Evaluate melt rate enhancements using heat-balance modeling (FY01-FY02, SRS, TFA).

INEEL SBW Melter Study

- Conduct a melt rate study for INEEL SBW (FY01, INEEL, TFA).
- Conduct laboratory studies on volatilization from treatment and immobilization process steps for SBW (FY01, INEEL, TFA).
- Demonstrate a melting process for INEEL SBW and calcine glass compositions (FY01-FY03, INEEL, SRS, TFA).
- Evaluate high-temperature melting for INEEL calcine wastes (FY02-FY03, INEEL, SRS, TFA).

Table 5.50. Budget Profile: Specify and Enhance Design and Operation of HLW Melters (TFA Technical Response A9768; Work Package WT-06-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL09WT31 RL37WT31	1115 200	 250	 400		
INEEL	ID77WT31	325	500	500		
ORR						
SRS	SR16WT31	900	865	925		
WVDP						
Subtotal		2540	1615	1825	TBD	TBD
ASTD						
CMST						
NETL						
ESP						
International						
Robotics						
University	FT07IP02	175				
EM-50 TFA Total		2715	1615	1825	TBD	TBD

New Melter Technology
(TFA Strategic Technical Response AA7S2; Work Package WT-06-01)

Waste streams at Hanford, INEEL, and SRS may benefit from immobilization in higher temperature glass formulations in advanced melters. Higher temperature melts are expected to result in higher waste oxide loading in the glass. The success of higher temperature glasses depends on the balance of operational issues such as melter material performance, volatility, glass chemistry stability in the melt, uniformity of product glass, REDOX, etc. and final glass performance and acceptance. Both Russia and France are developing high temperature cold crucible induction heated melters. Determination of the feasibility and applicability of this type of technology to U.S. waste streams is needed. The TFA is making a strategic investment to evaluate the induction-heated, cold-crucible melter technology as an alternative for vitrification of HLW and LLW tank wastes. TFA is undertaking a strategic task to:

- define the incentives for Hanford, SRS, and INEEL to go to high-temperature melters.
- demonstrate the CCM technology sufficiently to determine its readiness for production applications.
- define technology, operational, and safety issues requiring resolution for implementation in the United States.

An experimental program to be conducted at three Russian research facilities using the Russian CCMs was defined for implementation beginning late in FY00. The objectives of the Russian studies are to:

- define the incentive for increasing melting temperatures.
- identify important engineering parameters that must be addressed if the CCM technology is to be implemented.

Through the Agreement between the United States Department of Energy and the French Commissariat a L'Energie Atomique in the field of Radioactive Waste Management, the TFA plans to conduct an experimental program using the French CCM and Advanced CCM technologies. The objectives of the French studies are to:

- jointly develop higher melting temperature glasses relevant to Hanford, INEEL, and SRS.
- conduct demonstrations at sufficient scale and duration to demonstrate the CCM and/or Advanced CCM technology, identify engineering issues, and measure off gas.
- jointly evaluate data to fully define incentives for utilizing the CCM technology.

Table 5.51. Budget Profile: New Melter Technology (TFA Technical Response AA7S2; Work Package WT-06-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL09WT31 RL37WT31	240 35				
INEEL	ID77WT31	40				
ORR						
SRS	SR16WT31	35				
WVDP						

Table 5.51. (contd)

	TTP#	FY01	FY02	FY03	FY04	FY05
Subtotal		350	TBD			
ASTD						
CMST						
NETL						
ESP						
International	HQ06T222	100				
Robotics						
University						
EM-50 TFA Total		450	TBD			

Problem Element 1.3.1 Close Tanks

Problem Element 1.3.1 Description and Priority Site Needs

Closure of radioactive waste tanks requires sampling and/or characterization of waste tank residuals, definition of and compliance with 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. This will prevent subsidence of a tank, collapse of the tank dome, long-term migration of residual contaminants, or short-term release of residual waste contents due to catastrophic failure. Stabilization may include filling the tank with grout and stabilizing 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.

Closure of radioactive waste tanks is a key element in the tank sites' baseline plans for reducing mortgage and accelerating cleanup. SRS has closed two HLW tanks and will conduct a treatability study for closing its OBG tanks. ORR is preparing for future GAAT tank closures through the GAAT treatability study and will be closing its OHF tanks. INEEL is actively working toward meeting an Idaho milestone to close two of its tanks in FY03 and FY04. The site needs addressed in this problem element are identified below in Table 5.52.

Table 5.52. Problem Element 1.3.1. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ID-2.1.39	Acceptance Criteria for LAW Disposal in Underground Storage Tanks	ID-HLW-103	Tank Closure Criteria / Decision Support	22, 82, 2094, 2368
ID-2.1.42	Acceptance Criteria for Tank Closure	ID-HLW-105	Tank Closure Criteria / Decision Support	22, 82, 2094, 2368
ID-2.1.45	Acceptance Criteria for Grouting Tank Heels	ID-HLW-103	Tank Closure Criteria / Decision Support	22, 82, 2094, 2368
ID-2.1.46	Management of Tank Heel Liquids	ID-HLW-105	Enhanced Grout Formulations for Tank Closure	22, 82, 2094, 2368

Table 5.52. (contd)

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
ID-2.1.47	Management of Tank Heel Solids	ID-HWl-105	Enhanced Grout Formulations for Tank Closure	22, 82, 2094, 2368
ID-2.1.48	Wasteform Qualification for Low-Activity Waste in Underground Storage Tanks	ID-HLW-103	Tank Closure Criteria / Decision Support	22, 82, 2094, 2368
ID-2.1.62	Acceptance Criteria for Bin Set Closure	ID-HLW-103	Tank Closure Criteria / Decision Support	22, 82, 2094, 2368
ID-2.1.71	Grout/Heel Mix in Place System	ID-HLW-103	Demonstration of Grout Injection Technology for Tank Closure	22, 82, 2094, 2368
OR-TK-09	ORNL Tank Closure	OR-321 OR-322	Enhanced Grout Formulations for Tank Closure, Demonstration of Grout Injection Technology for Tank Closure	22, 2368
RL-WT013	Establish Retrieval Performance Evaluation Criteria	RL-TW04		
RL-WT046-S	Getter Materials	RL-TW04 RL-TW09	Related EMSP Project 65370	
RL-WT061	Reactive Barriers to Contaminant Migration	RL-TW04 RL-TW09	Reduced Radionuclide Mobility	82
RL-WT068	Radionuclide Source Term from Tank Residuals	RL-TW04		

Table 5.52. (contd)

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT069	Value of Information Decision Analysis for Tank Farm Closure	RL-TW04	Tank Closure Criteria / Decision Support	
SR00-2051	Technology to Mitigate Effects of Technetium Under Tank Closure Conditions	SR-HL03	Reduced Radionuclide Mobility	82, 233
SR00-3022	In Situ Grouting and/or Retrieval of Waste from Underground Tanks (Formerly Used for the Storage of Radioactive Solvents)	SR-ER02	Enhanced Grout Formulations for Tank Closure, Demonstration of Grout Injection Technology for Tank Closure	22, 2368
OH-WV-904	High Level Waste Tank Closure	OH-WV-01	Demonstration of Grout Injection Technology for Tank Closure,	22, 2368
OH-WV-914	Development of Grout for In-Situ Closure	OH-WV-01	Enhanced Grout Formulations for Tank Closure	

Problem Element 1.3.1 Technical Tasks

Enhance Grout Formulations for Tank Closure
(TFA Technical Response A9923; Work Package WT-05-01)

WVDP, ORR, SRS, and INEEL are planning to use grout as part of their overall tank closure strategies. The grouts would include reducing agents and sorbents for capturing and/or binding mobile radiological contaminants and would provide structural support for the backfill over the tanks. Any tank residuals must be shown to not compromise the integrity of the grout.

To address these needs, the TFA will fund tests to characterize the proposed groutformulations for the different sites and to improve the basic understanding of grout/waste chemistry.

Workscope to complete this task includes:

- Conduct tests with actual tank wastes to evaluate grout formulations being developed for tank closure applications (FY01, TFA).
- Conduct tests to determine the effectiveness of additives and sorbents for incorporation into tank closure grouts (FY01, FY02, TFA).

Table 5.53. Budget Profile: Enhanced Grout Formulations for Tank Closure (TFA Technical Response A9923; Work Package WT-05-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS						
WVDP						
EM-50 TFA Total		550	250			

Demonstration of Grout Injection Technology for Tank Closure
(TFA Technical Response A9985; Work Package WT-05-01 unfunded)

ORR, SRS, WVDP, and other DOE facilities have waste storage tanks that will require either complete removal or in-place stabilization of sludge heels remaining after retrieval operations. In many cases, complete removal of the heels can be extremely costly with negligible resulting benefits to health or to the environment. Residual contamination in the tank walls and liners may also dictate tank closure. An in-situ grouting process is under development to stabilize and close tanks with small amounts of residual heels and contamination. A multi-point, high-pressure grout injection technology was demonstrated on a cold basis in FY98 and again in FY99. This technology can accommodate the varying sizes and configurations of waste tanks across the DOE complex. This technology is ready for hot demonstration and deployment pending identification and selection of tanks by the sites.

Tank Closure Criteria/Decision Support
(TFA Technical Response A9924; Work Package WT-05-01, unfunded)

The INTEC at INEEL has 11 tanks that contain approximately 1.4 million gallons of radioactive liquid waste. A closure plan must be submitted to the Idaho Department of Environmental Quality by December 31, 2000. Moreover, two of the tanks (WM-182 and WM-183) are scheduled for early closure by 2003 and 2004. Tank WM-182 contains substantial internal piping in the tank bottom. Closure of this tank in 2003 will represent the first closure demonstration within the DOE complex of a tank containing a substantial amount of tank-floor, internal cooling system piping. Lessons learned from the INEEL WM-182 tank closure will be directly applicable to similar piping challenges facing WVDP and SRS. In addition, Tank WM-182 contains acidic waste liquid heels that contain some solids, both suspended and settled. Grouting these heels (after possible treatment) in place is a possible tank closure strategy. (A ROD scheduled for March 2001 will determine the tank closure strategy.) Moreover, the site is considering grouting and pumping LAW to existing underground storage tanks for permanent disposal on site.

Waste form acceptance criteria must be developed and approved to use tanks as a low-level Class A waste disposal facility.

Finally, INEEL has requested help in establishing acceptance criteria for closure of its bin sets. These bin sets contain granular solids and powder called calcine that was generated when liquid waste from its tanks was processed in the New Waste Calcining Facility. Similar to WM-182 tank closure, bin set closure will consider RCRA requirements, NRC requirements, DOE Orders, and the Settlement Agreement. Bin set closure is also similar to any tank closure in the sense that the goal is to minimize the risk of releasing hazardous or radioactive material to the environment.

Hanford needs to decide when it has sufficient information to proceed with a NEPA process for tank closure. It is requesting that a value-of-information, decision analysis methodology be demonstrated that will determine the value of gathering additional information on subsurface conditions, retrieval performance, and closure technologies before proceeding with a NEPA process for closure.

Workscope to address this need includes:

- Conduct yearly tank-closure technical exchange meetings to discuss tank closure issues and criteria.
- Conduct sensitivity/uncertainty analyses to identify key technology and data gaps that could affect successful tank closure.

Leaching and Treatment of Technetium (Tc) for Tank Closure
(TFA Technical Response A9588; Work Package WT-05-01 unfunded)

SRS and Hanford have identified a need to better understand the chemistry of Tc under the conditions of waste removal and after tank closure. SRS has identified a need to provide credible estimates of the Tc inventory in tank heels in order to determine if the tank can be closed. At a September 1998 Tc workshop conducted at Hanford, needs were identified for more accurate and more complete Tc characterization methods, more accurate inventory estimates for both soluble and insoluble Tc species in the Hanford tank wastes, and establishing non-pertechnetate Tc-species removal pretreatment options.

Workscope to address these needs includes:

- Determine the chemical characteristics of Tc in sludges.
- Evaluate Tc treatment and removal alternatives.
- Pursue relevant Tc chemistry work through the EMSP. EMSP is funding several related projects.
  - Continue EMSP and related research studies on the chemistry and speciation of Tc in waste tank storage environments.
  - Continue EMSP and related studies on processes for the reduction of the Tc oxidation state and other methods for chemical separation and enhanced immobilization of Tc.

Reduced Radionuclide Mobility
(TFA Technical Response A9960; Work Package WT-05-01, unfunded)

Sequestering agents can be used to attenuate the migration of key radionuclides from closed tanks, from previous tank leaks to the soil column, and from LLW disposal facilities. Tc-99 is the primary dose contributor in risk/performance assessments. Its mobility can also be reduced by creating a reducing environment. Hanford has not made any decisions regarding the addition of sequestering agents to tank farm soils, but is interested in further development of the technology as input to its planned NEPA process for closure. SRS used reducing grout to close its first two tanks and is interested in better understanding the range of the reducing zone beneath their tanks. This would allow for less conservative modeling that may lead to lower projected doses to the public from Tc-99 or reduced costs for waste removal.

To address these needs, the TFA will 1) estimate the extent of the reducing zone beneath a tank containing reducing grout; 2) evaluate 3M's EMPORE™ Tc-sequestering membrane technology for LLW disposal facility applications; and 3) test the durability and irreversibility of Hanford's candidate getter materials.

Workscope to complete these activities includes:

- Perform calculations and modeling to estimate the extent and duration of reducing zones beneath tanks closed with reducing grouts.
- Conduct experiments to provide data to support modeling and validation of modeling of the extent of the reducing zone.
- Conduct laboratory tests to determine the durability and reversibility of Hanford-identified getters for Tc-99, Se-79, and uranium.
- Conduct field tests on selected getter materials.
- Evaluate 3M's EMPORE™ Tc-sequestering membrane technology for LLW disposal facility applications.

Problem Element 1.3.2 Dispose of LLW

Problem Element 1.3.2 Description and Priority Site Needs

The immobilized low-activity or low-level waste (ILAW) from grouting operations at SRS, ORR, and possibly INEEL, and vitrification operations at Hanford will require, in most cases, onsite disposal. Regardless of the specific waste form selected by the site, process monitoring and/or product assessment is required to ensure the waste form meets disposal requirements. In addition, LLW disposal will require a 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 performance testing and ILAW disposal facility engineering. Needs exist for product acceptance testing to ensure the LLW immobilization process produces an acceptable waste form, data collection to support performance assessment efforts, and evaluation of disposal site barrier technologies to ensure the final disposal of the ILAW meets requirements. The following needs in Table 5.54 are addressed in this problem element.

Table 5.54. Problem Element 1.3.1. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT-015	Standard Method for Determining Waste Form Release Rate	RL-TW09	Testing and Prediction of Long Term Waste Glass Performance	82, 2094
RL-WT016	Glass Monolith Surface Area	RL-TW09	Glass Monolith Surface Area	82, 2094
RL-WT017	Long-Term Testing of Surface Barrier	RL-TW09	Barriers for Tank / Disposal Facility Closure	10, 523
RL-WT018	Testing of Sand-Gravel Capillary Barrier	RL-TW09	Barriers for Tank / Disposal Facility Closure	10, 523
RL-WT029	Data and Tools for Performance Assessments	RL-TW09	Data and Tools for Performance Assessments	82
RL-WT035-S	Moisture Flow an Contaminant Transport in Arid Conditions	RL-TW09		
RL-WT043-S	Effect of Human and Natural Influences on Long-Term water Distribution	RL-TW09		
RL-WT044-S	Distribution of Recharge Rates	RL-TW09		

Table 5.54. (contd)

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT045-S	Vadose Zone Flow Simulation Tool Under Arid Conditions	RL-TW09	Related EMSP Project 65410	
RL-WT056-S	Half-Lives of Se-79 and Sn-126	RL-TW09		
RL-WT066	Compositional Dependence of the Long Term Performance of Glass as a Low-Activity Waste Form	RL-TW09	Testing and Prediction of Long Term Waste Glass Performance	82, 2094
OH-WV-904	High Level Waste Tank Closure	OH-WV-01	Barriers for Tank / Disposal Facility Closure	22, 2368

Problem Element 1.3.2 Technical Tasks

Testing and Prediction of Long Term Waste Glass Performance
(TFA Technical Response A9748; Work Package WT-07-01)

Hanford plans to dispose of its LAW as a glass waste form in a near-surface disposal facility. The glass performance must be linked to the disposal facility to provide a valid performance assessment of the ILAW disposal system. A short-term test or suite of tests for evaluation of Hanford ILAW waste forms with respect to long-term performance is needed to provide a technical basis for the performance assessment and to provide a foundation for Hanford's ILAW product specifications.

To provide a technical basis for accepting ILAW and IHLW, glass composition regions that yield waste forms meeting the product specifications must be identified and documented. The information will provide 1) an independent verification of the results of waste form qualification activities; 2) a tool to accept actual ILAW and IHLW based on measured and reported compositions; and 3) an expanded database on the effect of glass components on long term performance.

This task will result in 1) an evaluation of a suite of tests and their relative importance and linkage to the performance assessment and long-term glass performance modeling; and 2) a bounding or qualified composition region with a high confidence of satisfying the long-term performance requirements. Workscope to complete these activities include:

- Conduct glass durability tests on selected ILAW glasses to determine long-term durability behavior (FY00-FY03, TFA, Hanford).
- Test ILAW glass formulations to define acceptable glass composition region for Hanford ILAW (FY00-FY03, TFA, Hanford).
- Document a recommended acceptable glass composition region (FY00-FY03, TFA, Hanford).
- Pursue relevant long-term glass performance work through the EMSP. EMSP is funding several related projects including "Analysis of Surface Leaching Processed in Vitrified High-Level Nuclear Wastes Using In-Situ Raman Imaging and Atomistic Modeling" (54982), "Quantifying Silica

Reactivity in Subsurface Environments. Controls of Reaction Affinity and Solute Matrix on Quartz and SiO2 Glass Dissolution Kinetics" (55042), and "Ion-Exchange Processes and Mechanisms in Glasses" (60362).

Table 5.55. Budget Profile: Testing and Prediction of Long Term Waste Glass Performance (TFA Technical Response A9748; Work Package WT-07-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
ANL	CH27WT31	80	60	30		
Hanford	RL37WT31	460	370	285		
INEEL						
ORR						
SRS	SR16WT31	460	370	285		
WVDP						
EM-50 TFA Total		1000	800	800	TBD	TBD

Glass Monolith Surface Area
(TFA Technical Response A9749; Work Package WT-10-01, funded through University Programs)

A method is needed to estimate the surface area of vitrified LAW. Performance assessment analyses of LLW disposal systems must estimate the source term from the disposal system. The source term is related to the surface area of the waste form that can be reached by moisture moving through the disposal system. To support performance assessment analyses of Hanford's ILAW disposal system, the following information regarding waste form cracking within a waste package is needed. 1) crack patterns, fines generation, and surface area of the glass waste form; 2) glass surface area reachable by moisture; 3) unsaturated hydraulic properties of the cracked glass; and 4) the impact of aging on these properties.

Workscope to complete this activity includes:

- Determine important variables that affect glass cracking and surface area.
- Characterize glass cracking in small-scale containers and prototypical ILAW glass packages.
- Evaluate non-intrusive methods for estimating the extent of cracking.

Barriers for Tank / Disposal Facility Closure
(TFA Technical Response A9950; Work Package WT-12-01, unfunded)

Infiltration control via infiltration barriers at the Hanford tank farms, the ILAW facility, and the WVDP tanks are important towards demonstrating that these facilities' performance requirements will be met. Because of cost and cultural value considerations, the Hanford Site is considering surface barrier designs (such as RCRA Subtitle C or sand-gravel capillary barriers) as variations on the historically identified "Hanford barrier." The design life for such barriers at Hanford is 1,000 years. WVDP's in-tank disposal conceptual design also includes slurry walls around their tanks to reduce side infiltration of moisture to residual waste locations and a multi-layered cap to reduce vertical infiltration. A long-term

infiltration barrier guidance document is desired that credibly ties barrier lifetimes (and uncertainties) to barrier design principles. Additional field testing of infiltration barriers is also desired, if necessary, to technically support the guidance document.

During FY00, the Subsurface Contaminant Focus Area initiated an activity to develop a long-term infiltration barrier guidance document. Personnel from numerous national laboratories and DOE sites (for example, Hanford, Fernald, Rocky Flats, Grand Junction, Sandia National Laboratories, etc.) are collaborating to develop this document. Another intent of the collaborative effort is to identify data gaps that need to be resolved to establish a firm basis for the guidance document. This latter effort should be valuable for determining the extent of additional field testing necessary to meet Hanford and WVDP needs.

Because the Subsurface Contaminants Focus Area infiltration barrier effort is satisfying site needs for a guidance document, the TFA will not develop a separate FY01-05 multiyear response for the Hanford and WVDP needs. The TFA will revisit whether it should develop a multiyear response for tank infiltration barriers after the sites have had an opportunity to review the current development effort and submit revised needs to the TFA.

Data and Tools for Performance Assessment
(TFA Technical Response A9958; Work Package WT-12-01, unfunded)

To support tank closure performance assessments for Hanford's ILAW disposal facility, the site needs improved understanding of moisture recharge rates and vadose zone hydrologic properties, because the arid conditions at Hanford are not accurately represented by the existing data.

Specifically with respect to extremely slow recharge rates, Hanford has requested that the range of factors that affect recharge for its ILAW facility be determined. This includes the effect of subsurface disposal facilities on recharge in the vicinity of these facilities and estimation of the spatial and temporal distribution of recharge rates in the vicinity of the disposal facility. Factors to be considered include soil type, vegetation, facility and surface cover design, human activity, climate, and time.

With respect to hydrologic properties, Hanford currently has measurements of the near-surface (first few feet) hydrologic properties, but lacks data at deeper vadose zone depths. Such hydrologic information is desired to support performance assessment calculations on contaminant mobility.

Workscope to address these data needs includes:

- Select field monitoring capability for determination of Hanford vadose zone hydrologic properties to depths of 100 feet.
- Perform infiltration field measurements of Hanford vadose-zone hydrologic properties.
- EMSP is funding several projects related to moisture and contaminant transport. TFA is interested in continuing relevant work through the science program and through applied research funding.
  - Continue development of promising EMSP and related technologies for measurement of moisture content, hydraulic properties, and contaminant concentrations in the vadose zone beneath tank and disposal sites.

- Continue EMSP and related scientific studies on moisture and contaminant transport properties including recharge rates, hydraulic properties, and contaminant retardation factors.

Continue development of EMSP and related computer models for describing moisture and contaminant transport in the vadose zone beneath tank and waste disposal sites. The EMSP project "Rapid Migration of Radionuclides Leaked from High-Level Waste Tanks. A Study of Salinity Gradients, Wetted Path Geometry and Water Vapor Transport" (65410) is of particular relevance.

Problem Element 1.3.3 Store and Dispose HLW

Problem Element 1.3.3 Description and Priority Site Needs

The IHLW from tank waste treatment operations at Hanford, SRS, and INEEL will be stored onsite before being shipped to a federal repository. To ensure the waste form meets disposal requirements, process monitoring and/or product characterization is required. In addition, HLW canisters may require decontamination before shipment to the repository. This problem element addresses the disposition of the HLW glass canisters and secondary wastes generated during waste processing operations. The following site needs are addressed in this problem element.

Table 5.56. Problem Element 1.3.3 Store and Dispose HLW

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
SR00-2029	Alternative DWPF Canister Decontamination Technology	SR-HL05	Alternative HLW Canister Decontamination Techniques	N/A
OH-WV-902	Decontamination of High-Level Waste (HLW) Canisters	OH-WV-02	Alternative HLW Canister Decontamination Techniques	2009

Problem Element 1.3.3 Technical Tasks

Alternative HLW Canister Decontamination Techniques
(TFA Technical Response A9772; Work Package WT-07-01, unfunded)

A new, more effective technology is required to decontaminate the DWPF and WVDP HLW canisters after being filled and welded shut. DWPF canister decontamination includes a water-frit slurry blast technique that removes contamination and oxides from the entire canister exterior surface. The waste from this process comes in two forms. Off-gas is routed to the facility vessel ventilation system and on to facility controlled ventilation exhaust. The water-frit slurry waste stream is pumped into the facility chemical process and is fed into the vitrification process stream, to minimize liquid waste production. This coupling of canister decontamination with chemical processing is less than optimum, could limit production rates in the future, and currently reduces operating flexibility. Ideally, a canister decontamination technique that resulted in only gases that are compatible with the existing ventilation system is preferable. This would minimize or eliminate the dual processing required for canister decontamination and chemical processing. Disposition of oxides and metals removed as part of the process should be specified consistent with the site flow sheets and regulatory requirements. Any constituents added to accomplish canister decontamination should be minimized and should be compatible with the SRS HLW waste management system. The WVDP canisters currently in storage have picked up contamination and must be decontaminated prior to shipment off-site for continued storage.

Workscope to address this need includes:

- Evaluate enhanced and alternative canister decontamination methods.
- Conduct a pilot-scale and/or full-scale nonradioactive demonstration of recommended enhancements or alternatives for canister decontamination.
- Procure a canister decontamination system.
- Conduct cold testing and qualification testing to demonstrate compliance with WAPS requirements.
- Install/deploy the canister decontamination system.
- Evaluate performance of the canister decontamination system.

Problem Element 1.4 Decontamination and Deactivation

Problem Element 1.4 Description and Priority Site Needs

Tank waste storage, retrieval, treatment, and immobilization activities use equipment that requires maintenance to ensure operations, decontamination, and equipment deactivation should failures occur. Radioactive operations frequently require remote operations to protect the health and safety of workers. This problem element provides the tools and processes necessary to ensure continued safe operations of waste storage and treatment facilities. Note. The Deactivation and Decommissioning Focus Area (DDFA) mission is to provide technologies to decontaminate and decommission DOE's surplus facilities. The TFA and DDFA share technical solutions where applicable. The following site needs in Table 5.57 are addressed in this problem element.

Table 5.57. Problem Element 1.3.1. Priority Site Needs

STCG Need Number	Need Title	PBS Number	Technical Task	OST Number
RL-WT021	Cleaning, Decontaminating and Upgrading Hanford Pits	RL-TW03	Remote Systems for Pit Operations and Maintenance	
SR00-2031	Develop Remote Technology to Improve DWPF Operations	SR-HL05	Remote Technologies for Process Cell Operations and Maintenance	2087, 2181, 2195
SR00-2037	Tank Heel Removal/Closure Technology – CTS Equipment Decontamination	SR-HL01, SR-HL02, SR-HL03	Remote Systems for Pit Operations and Maintenance	2087, 2181, 2195
SR00-2040	Demonstrate Remote Decommissioning and Disassembly of High Level Waste Processing Equipment	SR-HL05	Demonstrate Remote Disassembly of HLW Melters and Other Processing Equipment	2383
OH-WV-903	Vitrification Expended Material Processing	OH-WV-01	Demonstrate Remote Disassembly of HLW Melters and Other Processing Equipment	2383
OH-WV-904	High Level Waste Tank Closure	OH-WV-01		
OH-WV-908	Decontamination of High-Level Waste Contaminated Equipment	OH-WV-01	Technologies for Pit Operation Enhancement, Remote Operations / Maintenance and Disassembly	2087, 2181, 2195

Demonstrate Remote Disassembly of HLW Melters and Other Processing Equipment
(TFA Technical Response A9777; Work Package WT-06-01)

SRS and WVDP currently do not have the capability to size reduce, decontaminate, classify, and dispose of failed, highly-contaminated processing equipment. This task is divided into two parts. 1) the HLW melter and 2) the rest of the various pieces of equipment, jumpers, etc., that are required to operate and maintain the DWPF. The current approach to dealing with the melter is long-term storage in the canyon facilities on regulated storage pads, or in underground storage vaults. While storage is acceptable for the short term, technology must be developed to properly dispose of this equipment. This includes dismantling and size reduction of the equipment, decontamination and recycling of as much material as possible, disposal of the majority of the material as LLW, and disposal of the remaining HLW materials in a controlled repository or as a recycle stream.

A single failed melter could contain as much HLW glass as five canisters. It could contain additional contamination in the form of unmelted waste solids or as condensed volatile species such as Cs, Ru, and Tc. While failed melters are prime examples to demonstrate this need, it also applies to other equipment such as failed jumpers, off-gas system components, process tanks, equipment, pumps, and others.

This need does not apply just to SRS and WVDP. It spans the entire DOE complex wherever highly contaminated equipment is utilized or generated. Current robotic/telerobotic technology is capable of disassembly and decontamination of large equipment. These technologies must be adapted for radioactive application.

Workscope to address this need includes:

<u>Glass Removal from Failed Melters</u>

- Identify and evaluate methods for removing glass from failed melters (FY01, TFA, SRS, WVDP, Robotics).
- Conduct pilot-scale or full-scale non-radioactive demonstration of recommended method for removing glass from failed melter (FY02, TFA, SRS).
- Document demonstration of glass removal method (FY02, TFA, SRS, WVDP).

<u>Failed Equipment D&D, Size Reduction, and Sorting</u>

- Identify and evaluate methods to D&D, size-reduce, and sort failed melter components and other process equipment (FY01, TFA, SRS, WVDP, Robotics).
- Issue test plan for demonstration of failed equipment decontamination, size reduction, and sorting (FY02, TFA, SRS, WVDP, Robotics).
- Complete procurement and deployment of size reduction equipment at WVDP (FY00, ASTD, WVDP).
- Document deployment of size reduction equipment at WVDP (FY00, ASTD, WVDP).
- Procure equipment/services to demonstrate D&D, size reduction, and sorting of failed equipment (FY01 - FY03, TFA, SRS, WVDP, Robotics).
- Conduct pilot-scale and/or full-scale demonstrations of unit operations to D&D, size reduce and sort failed equipment (FY03, TFA, SRS, WVDP, Robotics)
- Demonstrate D&D, size reduction, and sorting of failed melter components and other process equipment (FY04, TFA, SRS, WVDP, Robotics).

Table 5.58. Budget Profile: Demonstrate Remote Disassembly of HLW Melters and Other Processing Equipment (TFA Technical Response A9777; Work Package WT-06-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford						
INEEL						
ORR						
SRS	SR16WT31	240	1215	875	40	
WVDP	OH00WT31	255	450	675	295	
Subtotal		495	1665	6550	335	TBD
ASTD						
CMST						
NETL						
ESP						
International						
Robotics	OR17C131	100	140	100	65	
University						
EM-50 TFA Total		595	1885	1600	400	TBD

Remote Systems for Pit Operations and Maintenance
(TFA Technical Response A9352; Work Package WT-04-01)

DOE waste sites have a number of remote equipment needs for enhancing operations, maintenance, and failed equipment removal/disassembly. Remote technology is needed at Hanford to enhance cleaning, decontamination and reconfiguration operations in radioactive jumper pits to support feed delivery to the waste treatment facilities. At SRS, the 299-H Concentration, Storage, and Transfer (CTS) Decontamination Facility is being retrofitted to make a decontamination, storage, and equipment size-reduction facility to support sludge and heel removal operations. Remote technologies are needed at SRS to decontaminate and package long-length HLW tank equipment to clear risers for HLW tank retrieval operations, as well as to perform remote operations for maintenance of SRS slurry pumps.

Working with the Robotics Crosscutting Program, the TFA is developing equipment systems to address these remote maintenance needs. The pit work at Hanford will be evaluated by SRS to leverage what is already underway at Hanford.

Workscope to address these needs includes:

<u>Hanford Enhanced Pit Operations</u>

- Complete cold testing of enhanced pit operations system (FY01, Robotics, Hanford).
- Conduct hot demonstration of pit operations system (FY01, Hanford).

- Procure second-generation pit operations system based on lessons-learned from hot demonstration (FY02, Robotics, Hanford).
- Deploy second-generation pit operations system (FY03, Robotics, Hanford).

SRS 299H Pit Operations

- Develop functions and requirements for 299H pit operations system (FY01, Robotics, SRS).
- Conduct mock-up tests of 299H pit operations (FY01, Robotics, SRS).
- Complete detailed design for 299H remote pit operations system (FY02, Robotics, SRS).
- Deploy 299H remote pit operations system (FY03, Robotics, SRS).

Table 5.59. Budget Profile: Technologies for Pit Operation Enhancement, Remote Operations/Maintenance and Disassembly (TFA Technical Response A9352; Work Package WT-04-01)

	TTP#	FY01	FY02	FY03	FY04	FY05
Hanford	RL09WT22	170	250	100		
INEEL						
ORR						
SRS	SR16WT51	150	500	900		
WVDP						
Subtotal		320	750	1000	TBD	TBD
ASTD						
CMST						
NETL						
ESP						
International						
Robotics	OR17C131 RL37C131 SR10C131	50 380 150	 450 1000	 250 300		
University						
EM-50 TFA Total		900	2200	1550	TBD	TBD

Remote Technologies for Process Cell Operations and Maintenance
(TFA Technical Response A9374; Work Package WT-10-01, unfunded)

The DWPF at SRS is limited in the ability to perform remote maintenance, inspection, and cleanup activities within the shielded facility (canyon). The only access to the majority of the facility for maintenance is via an overhead crane using hooks and an impact wrench. Viewing capability within the facility is limited to video cameras mounted on the Main Process Cell crane. It is desirable to develop improved capabilities to inspect, perform maintenance, and perform decontamination/cleanup activities within the facility.

Workscope to complete this activity includes:

- Develop requirements and specifications for DWPF process cell operations and maintenance equipment system.
- Complete procurement of DWPF process cell operations and maintenance equipment systems.
- Complete vendor acceptance and cold testing of DWPF process cell operations and maintenance equipment systems.
- Conduct radioactive demonstration of DWPF process cell operations and maintenance equipment systems.

Section 6.0 References

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Appendix A

Tanks Focus Area Organization

Appendix A

Tanks Focus Area Organization

This appendix provides the names of key Tanks Focus Area (TFA) team members. More TFA information 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.

A.1 TFA Organization and Functions

Before FY95, responsibility for remediating the U.S. Department of Energy's (DOE's) radioactive waste 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 high-level waste and transuranic 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 (PNNL) serves as the lead technical organization. Since the original proposal, site contractors have changed but the initial organizations remain the same. Presently, this team is composed of Idaho National Engineering and Environmental Laboratory (INEEL), Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL), Sandia National Laboratories (SNL), Westinghouse Savannah River Company (WSRC), and CH2M Hill Hanford Group (CHG). The DOE's Richland Operations Office (DOE-RL) serves as the lead operations 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). The TFA began operations in October 1994. See Figure A.1, Tanks Focus Area Organization.

The Technical Team is guided by the User Steering Group (USG) composed of senior managers from each of the Technical Team partners, including contractor user members from the five tank sites and three non-user members representing laboratories that participate on the team. The technical program proposed by the Technical Team is reviewed by the TFA Technical Advisory Group (TAG), which is composed of technical experts from industry, academia, and the DOE complex.

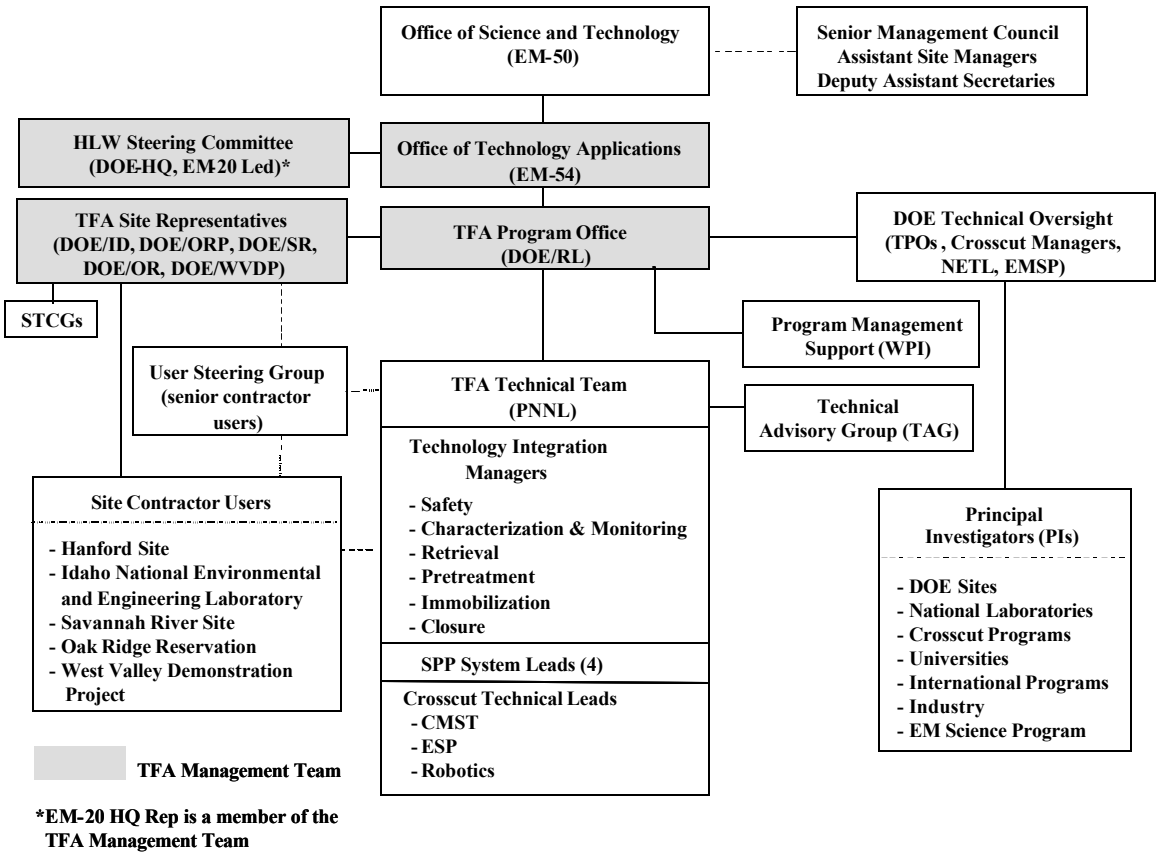

Figure A.1. Tanks Focus Area Organization

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

The TFA is responsible for science and technology development to support DOE's five major tank sites: Hanford, INEEL, ORR, SRS, and WVDP. Its technical scope covers the major functions that comprise a complete tank remediation system: safety, characterization, retrieval, pretreatment, immobilization, and closure. The TFA integrates tank-related activities across all organizations that fund tank science and technology within DOE's Office of Environmental Management, comprising the Offices of Integration and Disposition (EM-20), Site Closure (EM-30), Project Completion (EM-40), and Science and Technology (EM-50). The TFA also integrates 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.

The following lists provide the names and positions of key TFA personnel.

TFA Management Team
Ted Pietrok, TFA Program Manager, DOE-RL, Richland WA
Joe Cruz, Site Representative, DOE-ORP, Richland, WA
John Drake, Site Representative, DOE-OH, West Valley, NY
Kurt Gerdes, TFA DOE-HQ Program Manager, EM-54, DOE-HQ, Germantown, MD
Tom Gutmann, Site Representative, EM-30, DOE-SR, Aiken, SC
Keith Lockie, Site Representative, EM-30, DOE-ID, Idaho Falls, ID
Jacquie Noble-Dial (Daryl Green, Acting), Site Representative, EM-50, DOE-OR, Oak Ridge, TN
Ken Picha, EM-22 Representative, DOE-HQ, Germantown, MD
Tom Brouns, (Ex officio member), Technical Team Manager, PNNL, Richland, WA

TFA Program Office
Ted Pietrok, TFA Program Manager, DOE-RL, Richland, WA
Randy Brich, Program Execution Manager, DOE-RL, Richland, WA
Marcus Glasper, Program Integration Manager, DOE-RL, Richland, WA
Lance Mamiya, Program Execution Manager, DOE-RL, Richland, WA
Billie Mauss, Program Development Manager (on detail to ORP), DOE-RL, Richland, WA

Program Management Support
Mark Lucas, Manager, WPI
Sandy Briggs, Administrative, WPI
Eric Dysland, Technical, WPI
George Jacobson, Technical, WPI
Rohit Karamchandani, Technical (at DOE-HQ), SAIC
Vince Panesko, Technical, WPI
Mindy Pickard, Administrative, WPI
Mike Stover, Technical, SAIC
Janna Unterzuber, SAIC
Brian Walker, Technical, SAIC

TFA Technical Team
Tom Brouns, Technical Team Manager, PNNL, Richland, WA
Bob Allen, Strategic Operations Manager, PNNL, Richland, WA
Nikki Avery, Administrative Secretary, PNNL, Richland, WA
Betty Carteret, Technology Delivery Manager, PNNL, Richland, WA
Kim Collins, Clerk, PNNL, Richland, WA
Roger Gilchrist, Technical Integration Coordinator, PNNL, Richland, WA
Harry Harmon, Technology Development Manager, SRS Salt Processing Project, PNNL, Aiken, SC
Gary Josephson, Research Integration Manager, PNNL, Richland, WA
Cheryl Nickola, Program Operations Manager, PNNL, Richland, WA
Lynne Roeder-Smith, Technical Communications, PNNL, Richland, WA
Steve Schlahta, Deputy Technology Development Manager, SRS Salt Processing Project, PNNL, Aiken, SC
Janie Treadway, Business Operations Manager, PNNL, Richland, WA
Joe Westsik, Technical Program Development Manager, PNNL, Richland, WA
Bonnie Williams, Senior Administrative Secretary, PNNL, Richland, WA

Technology Integration Managers
Larry Bustard, Closure TIM, SNL, Albuquerque, NM
Pete Gibbons, Retrieval TIM, NHC, Richland, WA
Bill Holtzscheiter, Immobilization TIM, WSRC, Aiken, SC
Phil McGinnis, Pretreatment TIM, UT-Battelle, ORNL, Oak Ridge, TN
Mike Terry, Safety TIM, LANL, Richland, WA
Tom Thomas, Characterization TIM, Bechtel BWXT Idaho, Inc., INEEL, Idaho Falls, ID

Salt Processing Project System Leads
Sam Fink, SRTC, Aiken, SC
Joe Walker, UT-Battelle, ORNL, Oak Ridge, TN
Ken Rueter, WSRC, Aiken, SC
Dennis Wester, PNNL, Richland, WA

Crosscut Technical Leads
Glenn Bastiaans, CMST Program, Ames Laboratory, Iowa State University, Ames, IA
Barry Burks, Robotics Program, The Providence Group, Inc., Knoxville, TN
Jack Watson, ESP Program, UT-Battelle, ORNL, Oak Ridge, TN

TFA User Steering Group
Michael Baker, LANL, Las Alamos, NM
Fred Damerow, WVNS, West Valley, NY
Jim Honeyman, CHG, Inc., Richland, WA
Jerry Morin, WSRC, Aiken, SC
Susan Pickering, SNL, Albuquerque, NM
Rod Quinn, Battelle Albuquerque Office, Albuquerque, NM
Sharon Robinson, UT-Battelle, ORNL, Oak Ridge, TN
Jim Valentine, Bechtel BWXT Idaho, Inc., INEEL, Idaho Falls, ID

TFA Technical Advisory Group
Wally Schulz, TAG Chair, W2S Company, Inc., Albuquerque, NM
Jimmy Bell, TAG Deputy Chair, Bell Consultants, Inc., Kingston, TN

Pretreatment Subgroup
George Vandegrift, Subgroup Chair, Argonne National Laboratory, Argonne, IL
John Swanson, Private Consultant, Richland, WA
Major Thompson, WSRC, Aiken, SC

Characterization Subgroup
Bruce Kowalski, Subgroup Chair, Private Consultant, Hesperus, CO

Immobilization Subgroup
Tom Weber, Subgroup Chair, Private Consultant, Kennewick, WA
Joe Gentilucci, JAG Technical Services, Inc., Aiken, SC
Frank Woolley, Private Consultant, Cambridge, MA

Retrieval Subgroup
Paul Scott, Subgroup Chair, Pacific Northwest National Laboratory, Richland, WA
Brenda Lewis, WSRC, Aiken, SC

Safety Subgroup
Larry Tavlarides, Subgroup Chair, Syracuse University, Syracuse, NY

Closure Subgroup
Robert Erdmann, Subgroup Chair, Attorney, Grass Valley, CA
Jimmy Bell, TAG Deputy Chair, Bell Consultants, Inc., Kingston, TN
Dawn Kaback, Concurrent Technologies Corporation, Denver, CO

At-Large Members
Jimmy Bell, TAG Deputy Chair, Bell Consultants, Inc., Kingston, TN
John Carberry, DuPont Research & Development, Wilmington, DE
Greg Choppin, Florida State University, Tallahassee, FL
Gary Eller, Subgroup Chairman, LANL, Los Alamos, NM

Appendix B

STCG Needs/Prioritized Multiyear Response Table and Site Technology Crosswalk Table

Appendix B

STCG Needs/Prioritized Multiyear Response and Site Technology Crosswalk Tables

The TFA's prioritized multiyear response listing for FY01-02 appears in Table B.1. The table includes TFA's funding priority, TFA's Technical Response ID number, the associated work package, OST's Technology ID number, the Site Need ID number and the Need Title, and associated PBS number.

This table is the product of TFA's technical response prioritization that took place on March 9, 2000, in conjunction with TFA Midyear activities. During prioritization, the TFA Management Team assigned final scores to each technical response based on approved criteria. The Management Team discussed the merits of the response, focusing closely on aspects of site benefits, user commitment, and continuity of ongoing technology development. Additionally, the Management Team reviewed and approved six strategic tasks for inclusion into the FY01-02 program. At the conclusion of the prioritization session, the Management Team affirmed the results, thereby creating the official TFA01-02 Integrated Priority Listing (IPL).

The prioritization process serves at least three purposes for the TFA. First, it fine-tunes the program scheduled for execution in the upcoming fiscal year. Second, it forms the basis for development of the Corporate Review Budget (CRB) following the upcoming fiscal year's program. Third, it begins to define the program in the three years following the CRB year.

Table B.2, Site Technology Crosswalk Table, is a variation of Table B.1. Table B.2 organizes site needs and TFA multi-year responses by site.

Table B.1. STCG Needs/Prioritized Multiyear Response Table

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
0*	AA1S1	WT-05-01	85, 890, 1988	RL-WT05	Remote Inspection of High-Level Waste Single-Shell Tanks	RL-TW03
				RL-WT013	Establish Retrieval Performance Evaluation Criteria	RL-TW04
				RL-WT021	Cleaning, Decontaminating and Upgrading Hanford Pits	RL-TW03
				RL-WT022	Tank Knuckle NDE	RL-TW03
				RL-WT027	Tank Leak Mitigation Systems	RL-TW03
				RL-WT067	Improved DST Integrity NDE Measurement Tools	RL-TW03
				SR00-2035	Develop Advanced Techniques for Life Extension of High Level Waste Tanks and Piping	SR-HL01, SR-HL02, SR-HL03
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-HL03
				ID-2.1.20	Tank Annulus/Vault Inspection	ID-HLW-105
				ID-2.1.72	Alternate Heel Sampling Systems	ID-HLW-103
				OH-WV-907	High-Level Waste Tank Interim Maintenance	OH-WV-01
				ORTK-01	Tank Waste Characterization	OR-151
0*	AA3S1	WT-05-01	233, 1989, 2967	RL-WT023	Prediction of Solid Phase Formation in Static and Dynamic Hanford Tank Waste Solutions	RL-TW04
				RL-WT024	Enhanced Sludge Washing Process Data	RL-TW04
				RL-WT060	Better Waste Mixing Mobilization	RL-TW04
				RL-WT063	PHMC Retrieval and Closure - Hanford SST Saltcake Dissolution Retrieval	RL-TW04
				RL-WT064	PHMC Retrieval and Closure - Hanford Past Practice Sluicing Improvements	RL-TW04
				RL-WT070	Uncertainty Estimation of Hanford Best Basis Toxic Waste Inventory, Concentration, Phase and Waste Type	RL-TW01
				RL-WT071	Provide Laboratory Development Support and ESP Modeling Support for the Back Dilution of Tank 241-SY-101	RL-TW03
				SR00-2028	Alternative Waste Removal Technology	SR-HL02
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL03

* Represents a strategic task.

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
				SR00-2039	Methods to Unplug Waste Transfer Lines	SR-HL02
				SR00-2052	Aluminum Dissolution from HAW Sludge and Its Impact on Downstream Salt Processing	SR-HL05
				ORTK-04	Sludge Mixing and Slurry Transport	OR-321
				ORTK-05	Tank Sludge and Supernatant Separations	OR-311
				RL-WT037-S	Sludge Treatment	RL-TW04
				RL-WT038-S	Process Models for Sludge Treatment	RL-TW04
				RL-WT040-S	Mechanisms of Line Plugging	RL-TW04
				RL-WT049-S	Effect of Processing on Gas Release, Waste Sedimentation, Rheological, and Other Behaviors	RL-TW04
				RL-WT075-S	HLW Solid Phase Characterization	RL-TW01
				RL-WT078-S	Plutonium Segregation and Association in HLW	RL-TW04
0*	AA3S2	WT-03-01	1989, 2011, 2012, 2216	RL-WT013	Establish Retrieval Performance Evaluation Criteria	RL-TW04
				RL-WT027	Tank Leak Mitigation Systems	RL-TW03
				RL-WT063	PHMC Retrieval and Closure - Hanford SST Saltcake Dissolution Retrieval	RL-TW04
				RL-WT064	PHMC Retrieval and Closure - Hanford Past Practice Sluicing Improvements	RL-TW04
				SR00-2028	Alternative Waste Removal Technology	SR-HL01
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL02
				ORTK-02	Tank Solid Waste Retieval	OR-321
				RL-WT077-S	Improvements to Salt Well Pumping	RL-TW04

* Represents a strategic task.

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
0*	AA5S1	WT-08-01	233, 1989	RL-WT024	Enhanced Sludge Washing Process Data	RL-TW04
				RL-WT070	Uncertainty Estimation of Hanford Best Basis Toxic Waste Inventory, Concentration, Phase and Waste Type	RL-TW01
				SR00-2052	Aluminum Dissolution from HAW Sludge and Its Impact on Downstream Salt Processing	SR-HL05
				ORTK-05	Tank Sludge and Supernatant Separations	OR-151
				RL-WT037-S	Sludge Treatment	RL-TW04
				RL-WT038-S	Process Models for Sludge Treatment	RL-TW04
				RL-WT078-S	Plutonium Segregation and Association in HLW	RL-TW04
0*	AA7S1	WT-07-01	2009	RL-WT015	Standard Method for Determining Waste Form Release Rate	RL-TW09
				RL-WT066	Compositional Dependence of the Long Term Performance of Glass as a Low-Activity Waste Form	RL-TW09
				RL-WT080	Advanced/Improved Vitrification	RL-TW05
				RL-WT081	Sulfate Accumulation in Low Activity Waste	RL-TW05
				SR00-2032	Optimize Melter Glass Chemistry and Increase Waste Loading	SR-HL05
				SR00-2036	Develop Improved HLW Melter	SR-HL05
				ID-2.1.58	HAW Immobilization	ID-HLW-103
				ID-2.1.66	Treatment/Disposition of Spent Ion Exchange Resins	ID-HLW-103
0*	AA7S2	WT-06-01	2009	RL-WT080	Advanced/Improved Vitrification	RL-TW05
				SR00-2032	Optimize Melter Glass Chemistry and Increase Waste Loading	SR-HL05
				SR00-2036	Develop Improved HLW Melter	SR-HL05
				ID-2.1.57	Conditioning of HAW for Treatment	ID-HLW-103
				ID-2.1.58	HAW Immobilization	ID-HLW-103
				ID-2.1.66	Treatment/Disposition of Spent Ion Exchange Resins	ID-HLW-103

* Represents a strategic task.

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
1	A9143	WT-04-01	1985, 2015	RL-WT04	Double-Shell Tank Corrosion Monitoring	RL-TW03
				SR00-2045	In-Situ Waste Tank Corrosion Probe	SR-HL03
				ORTK-01	Tank Waste Characterization	OR-151
				RL-WT079-S	Double Shell Tanks Corrosion Chemistry	RL-TW03
2	A9586	WT-09-01	20	SR00-1011	Demonstrate Evaporation Technologies to Reduce Generation of Secondary Waste Volume from Consolidated Incineration Facility	SR-SW01
				ORTK-05	Tank Sludge and Supernatant Separations	OR-151
				ORTK-11	Tank Supernatant Pretreatment	OR-311
3	A9768	WT-06-01	2009, 2092	RL-WT080	Advanced/Improved Vitrification	RL-TW05
				SR00-2036	Develop Improved HLW Melter	SR-HL05
				ID-2.1.57	Conditioning of HAW for Treatment	ID-HLW-103
				ID-2.1.58	HAW Immobilization	ID-HLW-103
				ID-2.1.66	Treatment/Disposition of Spent Ion Exchange Resins	ID-HLW-103

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
4	A9554	WT-08-01	1989, 2367	RL-WT023	Prediction of Solid Phase Formation in Static and Dynamic Hanford Tank Waste Solutions	RL-TW04
				RL-WT063	PHMC Retrieval and Closure - Hanford SST Saltcake Dissolution Retrieval	RL-TW04
				RL-WT071	Provide Laboratory Development Support and ESP Modeling Support for the Back Dilution of Tank 241-SY-101	RL-TW03
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01
				SR00-2039	Methods to Unplug Waste Transfer Lines	SR-HL01
				ORTK-04	Sludge Mixing and Slurry Transport	OR-321
				RL-WT040-S	Mechanisms of Line Plugging	RL-TW04
				RL-WT049-S	Effect of Processing on Gas Release, Waste Sedimentation, Rheological, and Other Behaviors	RL-TW04
				RL-WT075-S	HLW Solid Phase Characterization	RL-TW01
				RL-WT078-S	Plutonium Segregation and Association in HLW	RL-TW04
5	A9773	WT-06-01	2009	RL-WT080	Advanced/Improved Vitrification	RL-TW05
				RL-WT081	Sulfate Accumulation in Low Activity Waste	RL-TW05
				RL-WT084	Extension of Glass Properties Model to Lower Silica Compositions	RL-TW04
				SR00-2032	Optimize Melter Glass Chemistry and Increase Waste Loading	SR-HL05
				SR00-2036	Develop Improved HLW Melter	SR-HL05
				ID-2.1.58	HAW Immobilization	ID-HLW-103
				ID-2.1.66	Treatment/Disposition of Spent Ion Exchange Resins	ID-HLW-103
6	A9570	WT-09-01	21	RL-WT082	Crystalline Silicotitanate Non-Elutable Sorbent	RL-TW05
				SR00-2034	Second Generation Salt Feed Preparation	SR-HL13
				ID-2.1.28	Cs and Sr Removal from Newly Generated Liquid Waste	ID-HLW-103
				ORTK-11	Tank Supernatant Pretreatment	OR-311

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
7	A9709	WT-06-01	TBD	SR00-2055	Increase in Applicability/Efficiency of High-Level Waste Planning Tool	SR-HL05
				ID-2.1.24	Integration/Optimization of High Activity Waste/Low Activity Waste Process Flowsheet	ID-HLW-103
				ID-2.1.65	Treatment/Disposition of Removed Tank Solids	ID-HLW-103
8	A9365	WT-02-01	TBD	RL-WT062	Variable Suction Level Transfer Pump	RL-TW04
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01
				ID-2.1.67	High Level Waste Slurry Handling	ID-HLW-103
9	A9555	WT-08-01	233	RL-WT024	Enhanced Sludge Washing Process Data	RL-TW04
				RL-WT070	Uncertainty Estimation of Hanford Best Basis Toxic Waste Inventory, Concentration, Phase and Waste Type	RL-TW01
				SR00-2052	Aluminum Dissolution from HAW Sludge and Its Impact on Downstream Salt Processing	SR-HL05
				ORTK-05	Tank Sludge and Supernatant Separations	OR-151
				RL-WT037-S	Sludge Treatment	RL-TW04
				RL-WT038-S	Process Models for Sludge Treatment	RL-TW04
				RL-WT078-S	Plutonium Segregation and Association in HLW	RL-TW04
10	A9923	WT-05-01	22	SR00-3022	In-Situ Grouting and/or Retrieval of Waste from Underground Tanks (Formerly Used for the Storage of Radioactive Solvents)	SR-ER02
				ID-2.1.46	Management of Tank Heel Liquids	ID-HLW-105
				ID-2.1.47	Management of Tank Heel Solids	ID-HLW-105
				OH-WV-914	Development of Grout for In-Situ Closure	OH-WV-01
				ORTK-09	Tank Closure	OR-321

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
11	A9175	WT-03-01	TBD	RL-WT05	Remote Inspection of High-Level Waste Single-Shell Tanks	RL-TW03
				RL-WT022	Tank Knuckle NDE	RL-TW03
				RL-WT067	Improved DST Integrity NDE Measurement Tools	RL-TW03
				SR00-2035	Develop Advanced Techniques for Life Extension of High Level Waste Tanks and Piping	SR-HL01
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL03
				ID-2.1.20	Tank Annulus/Vault Inspection	ID-HLW-105
				OH-WV-907	High-Level Waste Tank Interim Maintenance	OH-WV-01
				ORTK-01	Tank Waste Characterization	OR-151
12	A9376	WT-01-01	2367	RL-WT023	Prediction of Solid Phase Formation in Static and Dynamic Hanford Tank Waste Solutions	RL-TW04
				SR00-2039	Methods to Unplug Waste Transfer Lines	SR-HL01
				RL-WT040-S	Mechanisms of Line Plugging	RL-TW04
13	A9777	WT-06-01	2009, 2383	SR00-2040	Demonstrate Remote Decommissioning and Disassembly of High Level Waste Processing Equipment	SR-HL05
				OH-WV-903	Vitrification Expended Material Processing (WVDP-3-99)	OH-WV-04
14	A9719	WT-07-01	82	ID-2.1.23	Low-Activity Wasteform Qualification	ID-HLW-103
				ID-2.1.28	Cs and Sr Removal from Newly Generated Liquid Waste	ID-HLW-103
				ID-2.1.35	Direct Immobilization of INTEC Sodium-Bearing and Newly Generated Liquid Wastes	ID-HLW-103
				ID-2.1.38	Conditioning of Low Activity Waste for Treatment	ID-HLW-103
				ID-2.1.40	Low Activity Waste Grout Sorbent Addition to Reduce Leachability	ID-HLW-103
				ID-2.1.66	Treatment/Disposition of Spent Ion Exchange Resins	ID-HLW-103
				ORTK-06	Tank Sludge Supernatant Immobilization	OR-311
15	A9171	WT-04-01	2091	SR00-2027	Demonstrate Alternative Filtration Technologies to Replace HEPA Filters	SR-HL02
				ID-2.1.27	Blowback Metal Filters for Solids (Calcine) Retrieval	ID-HLW-103

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
16	A9361	WT-03-01	2948	ID-2.1.67	High Level Waste Slurry Handling	ID-HLW-103
				OH-WV-905	Retrieval of Tank Heels	OH-WV-01
17	A9363	WT-05-01	2967	SR00-2037	Tank Heel Removal/Closure Technology	SR-HL02
18	AA203	WT-02-01	2010	RL-WT013	Establish Retrieval Performance Evaluation Criteria	RL-TW04
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01
				ID-2.1.72	Alternate Heel Sampling Systems	ID-HLW-103
19	A9362	WT-02-01	1989	RL-WT063	PHMC Retrieval and Closure - Hanford SST Saltcake Dissolution Retrieval	RL-TW04
				SR00-2028	Alternative Waste Removal Technology	SR-HL01
				RL-WT077-S	Improvements to Salt Well Pumping	RL-TW04
20	A9157	WT-03-01	140, 2095	RL-WT027	Tank Leak Mitigation Systems	RL-TW03
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL02
21	A9246	WT-01-01	85, 2119, 2235, 2386	RL-WT09	Representative Sampling and Associated Analysis to Support Operations and Disposal	RL-TW05
				ID-2.1.26	Direct Tank Sampler for Tank Solution Characterization	ID-HLW-101
				ID-2.1.43	Certify LDUA Sampler as EPA-Approved Method of Sampling Tank Heel Liquids	ID-HLW-105
				ID-2.1.44	Certify LDUA Sampler as EPA-Approved Method of Sampling Tank Heel Solids	ID-HLW-103
22	A9584	WT-08-01	350	ID-2.1.64	Solid-Liquid Separation Equipment Development and Application	ID-HLW-103
23	A9352	WT-04-01	2087, 2181, 2195	RL-WT021	Cleaning, Decontaminating and Upgrading Hanford Pits	RL-TW03
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL03
24	A9501	WT-09-01	21, 347, 410, 841, 2968	ID-2.1.06	TRU, Cs and Sr Removal from High Activity Wastes	ID-HLW-103
				ID-2.1.56	Mercury Treatment for Aluminum Calcine	ID-HLW-103
				ID-2.1.68	Technetium Removal from INEEL High Level Waste	ID-HLW-101

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
25	A9748	WT-07-01	82, 2094	RL-WT015	Standard Method for Determining Waste Form Release Rate	RL-TW09
				RL-WT066	Compositional Dependence of the Long Term Performance of Glass as a Low-Activity Waste Form	RL-TW09
26	A9367	WT-03-01	85, 860, 2012, 2097, 2115, 2117, 2194	RL-WT013	Establish Retrieval Performance Evaluation Criteria	RL-TW04
				RL-WT064	PHMC Retrieval and Closure - Hanford Past Practice Sluicing Improvements	RL-TW04
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL03
				ORTK-02	Tank Solid Waste Retieval	OR-321
27	A9382	WT-02-01	TBD	RL-WT085	Retrieval of Waste Heel from 340 Radioactive Liquid (Low-Level / Mixed Waste Vault) Vault Tanks	RL-WM05
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL02
				OH-WV-905	Retrieval of Tank Heels	OH-WV-01
				ORTK-02	Tank Solid Waste Retieval	OR-321
28	A9508	WT-04-01	TBD	ID-2.1.16	Decontamination Facility/Analytical Facility Waste Reduction	ID-HLW-101
				ID-2.1.17	Develop New Filter Leach Process	ID-HLW-101
29	A9566	WT-11-01	2009	SR00-2033	Provide Alternative Processing and/or Concentration Methods for DWPF Recycle Aqueous Streams	SR-HL01
30	A9924	WT-05-01	22, 2369	RL-WT069	Value of Information Decision Analysis for Tank Farm Closure	RL-TW04
				ID-2.1.39	Acceptance Criteria for LAW Disposal in Underground Storage Tanks	ID-HLW-103
				ID-2.1.42	Acceptance Criteria for Tank Closure	ID-HLW-105
				ID-2.1.45	Acceptance Criteria for Grouting Tank Heels	ID-HLW-103
				ID-2.1.48	Wasteform Qualification for Low-Activity Waste in Underground Storage Tanks	ID-HLW-103
				ID-2.1.62	Acceptance Criteria for Bin Set Closure	ID-HLW-103
31	A9331	WT-02-01	TBD	ID-2.1.50	Solids Waste (Calcine) Retrieval	ID-HLW-103
				ID-2.1.69	Solids Waste (Calcine) Retrieval from CSSF1	ID-HLW-103

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
32	AA202	WT-02-01	2010	SR00-2044	In-Situ Technology for Waste Characterization	SR-HL01
				OH-WV-906	Radioactivity Measurement of High-Level Waste Tank Residuals	OH-WV-01
				RL-WT031-S	Rapid Waste Characterization	RL-TW01
33	A9156	WT-12-01	140	RL-WT026	Tank Leak Detection Systems for Underground Single-Shell Waste Storage Tanks (SSTs)	RL-TW03
34	A9359	WT-02-01	2232, 2370, 2408	RL-WT060	Better Waste Mixing Mobilization	RL-TW04
				SR00-2028	Alternative Waste Removal Technology	SR-HL01
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL03
				SR00-2041	Develop Advanced Mixing Technology	SR-HL01
				ORTK-02	Tank Solid Waste Retieval	OR-321
				RL-WT054-S	Solids Yield During Mixer Pump Mobilization	RL-TW04
35	A9278	WT-08-01	1547	RL-WT09	Representative Sampling and Associated Analysis to Support Operations and Disposal	RL-TW01
				SR00-2037	Tank Heel Removal/Closure Technology	SR-HL02
				SR00-2044	In-Situ Technology for Waste Characterization	SR-HL02
				ID-2.1.67	High Level Waste Slurry Handling	ID-HLW-103
				ORTK-04	Sludge Mixing and Slurry Transport	OR-321
				RL-WT032-S	Monitoring of Key Waste Physical Properties During Retrieval and Transport	RL-TW04
36	A9960	WT-05-01	TBD	RL-WT061	Reactive Barriers to Contaminant Migration	RL-TW09
				SR00-2051	Technology to Mitigate Effects of Technetium Under Tank Closure Conditions	SR-HL03
				RL-WT046-S	Getter Materials	RL-TW09

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
37	A9264	WT-11-01	127	RL-WT01	Technetium-99 Analysis in Hanford Tank Waste and Contaminated Tank Farm Areas	RL-TW01
				RL-WT065	Direct Inorganic and Organic Analyses of High-Level Waste	RL-TW04
				RL-WT083	Rapid PCB Screening Technology	RL-TW04
				ID-2.1.16	Decontamination Facility/Analytical Facility Waste Reduction	ID-HLW-101
				RL-WT052-S	Characterization of Organic Species in Waste Feed to LAW and HLW Treatment Facilities	RL-TW01
				SR00-2054-S	Develop Improved Radiochemical Analysis for High Ionic Strength Samples	SR-HL02
38	A9772	WT-07-01	2009	SR00-2029	Alternate DWPF Canister Decon Technology	SR-HL05
				OH-WV-902	Decontamination of High-Level Waste (HLW) Canisters (WVDP-2-99)	OH-WV-02
39	A9749	WT-10-01	82, 2094	RL-WT016	Glass Monolith Surface Area	RL-TW09
40	A9985	WT-05-01	2368	SR00-3022	In-Situ Grouting and/or Retrieval of Waste from Underground Tanks (Formerly Used for the Storage of Radioactive Solvents)	SR-ER02
				ID-2.1.71	Grout/Heel Mix in Place System	ID-HLW-103
				OH-WV-904	High Level Waste Tank Closure	OH-WV-01
				ORTK-09	Tank Closure	OR-321
41	A9588	WT-05-01	241	RL-WT068	Radionuclide Source Term from Tank Residuals	RL-TW04
				SR00-2051	Technology to Mitigate Effects of Technetium Under Tank Closure Conditions	SR-HL03
42	A9374	WT-10-01	TBD	SR00-2031	Develop Remote Technology to Improve DWPF Operations	SR-HL05
43	A9514	WT-11-01	TBD	ID-2.1.29	Evaluate Chloride Corrosion Potential (LET&D/PEWE/Future Processes)	ID-HLW-101
				ID-2.1.30	Remove/Treat Chlorides (LET&D/PEWE/Future Processes)	ID-HLW-101
44	AA303	WT-12-01	2011, 2967	SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01
45	AA310	WT-12-01	TBD	OH-WV-904	High Level Waste Tank Closure	OH-WV-01

Table B.1. (contd)

TFA Priority	Response ID	Work Package	OST Tech ID#	Site Need ID	Need Title	PBS#
46	A9518	WT-11-01	TBD	ID-2.1.36	Mercury Removal from Liquid Wastes	ID-HLW-101
				ID-2.1.56	Mercury Treatment for Aluminum Calcine	ID-HLW-103
47	AA201	WT-11-01	130	SR00-2044	In-Situ Technology for Waste Characterization	SR-HL03
48	A9532	WT-11-01	881	ID-2.1.51	Develop Calcine Dissolution Kinetics for Solid/Liquid Equilibria	ID-HLW-103
				ID-2.1.52	Characterization of Solids from Calcine Dissolution	ID-HLW-103

Table B.2. Site Technology Crosswalk Table

Site Need ID	Need Title	PBS#	TFA MYTR#	RespTitle	WP#	PE#
HANFORD						
RL-WT01	Technetium-99 Analysis in Hanford Tank Waste and Contaminated Tank Farm Areas	RL-TW01	A9264	Improve Waste Analytical Methods	WT-11-01	1.1.3
RL-WT04	Double-Shell Tank Corrosion Monitoring	RL-TW03	A9143	HLW Tank Corrosion Control and Monitoring	WT-04-01	1.1.1.1
RL-WT05	Remote Inspection of High-Level Waste Single-Shell Tanks	RL-TW03	A9175	Tank Integrity Inspection Techniques	WT-03-01	1.1.1.1
			AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
RL-WT09	Representative Sampling and Associated Analysis to Support Operations and Disposal	RL-TW01, RL-TW05	A9246	Waste Sampling and At-Tank Analysis	WT-01-01	1.1.3
			A9278	Slurry Transfer and Tank Waste Mixing Monitors	WT-08-01	
RL-WT013	Establish Retrieval Performance Evaluation Criteria	RL-TW04	AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
			AA203	Residual Waste Sampling	WT-02-01	1.1.3
			AA3S2	SST Retrieval from Potential Leaking Tanks	WT-03-01	1.2.1.2
			A9367	Unobstructed Tank Heel Retrieval		
RL-WT015	Standard Method for Determining Waste Form Release Rate	RL-TW09	A9748	Testing and Prediction of Long-Term Waste Glass Performance	WT-07-01	1.3.2
			AA7S1	Durability of Multiphase Waste Glasses	WT-07-01	1.2.3.2
RL-WT016	Glass Monolith Surface Area	RL-TW09	A9749	Glass Monolith Surface Area	WT-10-01	1.3.2
RL-WT021	Cleaning, Decontaminating and Upgrading Hanford Pits	RL-TW03	AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
			A9352	Remote Systems for Pit Operations and Maintenance	WT-04-01	1.4
RL-WT022	Tank Knuckle NDE	RL-TW03	AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
			A9175	Tank Integrity Inspection Techniques	WT-03-01	1.1.1.1
RL-WT023	Prediction of Solid Phase Formation in Static and Dynamic Hanford Tank Waste Solutions	RL-TW04	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			A9554	Hanford Tank Waste Chemistry	WT-08-01	1.2.2.3
			A9376	Waste Transfer Line Plugging Prevention and Unplugging Methods	WT-01-01	1.2.1.4
RL-WT024	Enhanced Sludge Washing Process Data	RL-TW04	A9555	Sludge Washing and Dissolution	WT-08-01	1.2.2.7
			AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			AA5S1	Removal of Key Non-Radioactive Elements from Tank Waste	WT-08-01	1.2.2.7
RL-WT026	Tank Leak Detection Systems for Underground Single-Shell Waste Storage Tanks (SSTs)	RL-TW03	A9156	Tank Leak Detection	WT-12-01	1.2.1.5

Table B.2. (contd)

Site Need ID	Need Title	PBS#	TFA MYTR#	RespTitle	WP#	PE#
RL-WT027	Tank Leak Mitigation Systems	RL-TW03	A9157	Tank Leak Mitigation	WT-03-01	1.2.1.5
			AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
			AA3S2	SST Retrieval from Potential Leaking Tanks	WT-03-01	1.2.1.2
RL-WT060	Better Waste Mixing Mobilization	RL-TW04	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			A9359	Waste Mixing and Retrieval	WT-02-01	
RL-WT061	Reactive Barriers to Contaminant Migration	RL-TW04, RL-TW09	A9960	Sequestering of Contaminant Migration	WT-05-01	1.3.1
RL-WT062	Variable Suction Level Transfer Pump	RL-TW04	A9365	Waste Transfer Pumping	WT-02-01	1.2.1.4
RL-WT063	PHMC Retrieval and Closure - Hanford SST Saltcake Dissolution Retrieval	RL-TW04	AA3S2	SST Retrieval from Potential Leaking Tanks	WT-03-01	1.2.1.2
			A9554	Hanford Tank Waste Chemistry	WT-08-01	1.2.2.3
			AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			A9362	Salt Cake Dissolution Retrieval	WT-02-01	1.2.1.2
RL-WT064	PHMC Retrieval and Closure - Hanford Past Practice Sluicing Improvements	RL-TW04	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			AA3S2	SST Retrieval from Potential Leaking Tanks	WT-03-01	
			A9367	Unobstructed Tank Heel Retrieval	WT-03-01	
RL-WT065	Direct Inorganic and Organic Analyses of High-Level Waste	RL-TW04	A9264	Improve Waste Analytical Methods	WT-11-01	1.1.3
RL-WT066	Compositional Dependence of the Long Term Performance of Glass as a Low-Activity Waste Form	RL-TW09	AA7S1	Durability of Multiphase Waste Glasses	WT-07-01	1.2.3.2
			A9748	Testing and Prediction of Long-Term Waste Glass Performance	WT-07-01	1.3.2
RL-WT067	Improved DST Integrity NDE Measurement Tools	RL-TW03	AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
			A9175	Tank Integrity Inspection Techniques	WT-03-01	1.1.1.1
RL-WT068	Radionuclide Source Term from Tank Residuals	RL-TW04	A9588	Leaching and Treatment of Technetium for Tank Closure	WT-05-01	1.3.1
RL-WT069	Value of Information Decision Analysis for Tank Farm Closure	RL-TW04	A9924	Tank Closure Criteria/Decision Support	WT-05-01	1.3.1
RL-WT070	Uncertainty Estimation of Hanford Best Basis Toxic Waste Inventory, Concentration, Phase and Waste Type	RL-TW01	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			AA5S1	Removal of Key Non-Radioactive Elements from Tank Waste	WT-08-01	1.2.2.7
			A9555	Sludge Washing and Dissolution		

Table B.2. (contd)

Site Need ID	Need Title	PBS#	TFA MYTR#	RespTitle	WP#	PE#
RL-WT071	Provide Laboratory Development Support and ESP Modeling Support for the Back Dilution of Tank 241-SY-101	RL-TW03	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			A9554	Hanford Tank Waste Chemistry	WT-08-01	1.2.2.3
RL-WT080	Advanced/Improved Vitrification	RL-TW05	AA7S2	New Melter Technology	WT-06-01	1.2.3.2
			AA7S1	Durability of Multiphase Waste Glasses	WT-07-01	
			A9768	Specify and Enhance Design of HLW Glass Melters	WT-06-01	
			A9773	Improve Waste Loading in HLW Glass	WT-06-01	
RL-WT081	Sulfate Accumulation in Low Activity Waste	RL-TW05	A9773	Improve Waste Loading in HLW Glass	WT-06-01	1.2.3.2
			AA7S1	Durability of Multiphase Waste Glasses	WT-07-01	
RL-WT082	Crystalline Silicotitanate Non-Elutable Sorbent	RL-TW05	A9570	Salt Disposition	WT-09-01	1.2.2.5
RL-WT083	Rapid PCB Screening Technology	RL-TW04	A9264	Improve Waste Analytical Methods	WT-11-01	1.1.3
RL-WT084	Extension of Glass Properties Model to Lower Silica Compositions	RL-TW04	A9773	Improve Waste Loading in HLW Glass	WT-06-01	1.2.3.2
RL-WT085	Retrieval of Waste Heel from 340 Radioactive Liquid (Low-Level / Mixed Waste Vault) Vault Tanks	RL-WM05	A9382	Horizontal and Small Tank Sludge Mixing and Retrieval	WT-02-01	1.2.1.2
RL-WT031-S	Rapid Waste Characterization	RL-TW01	AA202	In-Situ Waste Characterization	WT-02-01	1.1.3
RL-WT032-S	Monitoring of Key Waste Physical Properties During Retrieval and Transport	RL-TW04	A9278	Slurry Transfer and Tank Waste Mixing Monitors	WT-08-01	1.1.3
RL-WT037-S	Sludge Treatment	RL-TW04	AA5S1	Removal of Key Non-Radioactive Elements from Tank Waste	WT-08-01	1.2.2.7
			AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			A9555	Sludge Washing and Dissolution	WT-08-01	1.2.2.7
RL-WT038-S	Process Models for Sludge Treatment	RL-TW04	A9555	Sludge Washing and Dissolution	WT-08-01	1.2.2.7
			AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			AA5S1	Removal of Key Non-Radioactive Elements from Tank Waste	WT-08-01	1.2.2.7
RL-WT040-S	Mechanisms of Line Plugging	RL-TW04	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			A9554	Hanford Tank Waste Chemistry	WT-08-01	1.2.2.3
			A9376	Waste Transfer Line Plugging Prevention and Unplugging Methods	WT-01-01	1.2.1.4

Table B.2. (contd)

Site Need ID	Need Title	PBS#	TFA MYTR#	RespTitle	WP#	PE#
RL-WT046-S	Getter Materials	RL-TW04, RL-TW09	A9960	Sequestering of Contaminant Migration	WT-05-01	1.3.1
RL-WT049-S	Effect of Processing on Gas Release, Waste Sedimentation, Rheological, and Other Behaviors	RL-TW04	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			A9554	Hanford Tank Waste Chemistry	WT-08-01	1.2.2.3
RL-WT052-S	Characterization of Organic Species in Waste Feed to LAW and HLW Treatment Facilities	RL-TW01	A9264	Improve Waste Analytical Methods	WT-11-01	1.1.3
RL-WT054-S	Solids Yield During Mixer Pump Mobilization	RL-TW04	A9359	Waste Mixing and Retrieval	WT-02-01	1.2.1.2
RL-WT075-S	HLW Solid Phase Characterization	RL-TW01	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			A9554	Hanford Tank Waste Chemistry	WT-08-01	1.2.2.3
RL-WT077-S	Improvements to Salt Well Pumping	RL-TW04	A9362	Salt Cake Dissolution Retrieval	WT-02-01	1.2.1.2
			AA3S2	SST Retrieval from Potential Leaking Tanks	WT-03-01	
RL-WT078-S	Plutonium Segregation and Association in HLW	RL-TW04	A9554	Hanford Tank Waste Chemistry	WT-08-01	1.2.2.3
			A9555	Sludge Washing and Dissolution	WT-08-01	1.2.2.7
			AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			AA5S1	Removal of Key Non-Radioactive Elements from Tank Waste	WT-08-01	1.2.2.7
RL-WT079-S	Double Shell Tanks Corrosion Chemistry	RL-TW03	A9143	HLW Tank Corrosion Control and Monitoring	WT-04-01	1.1.1.1
IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY						
ID-2.1.06	TRU, Cs and Sr Removal from High Activity Wastes	ID-HLW-103	A9501	INEEL Integrated Radionuclide Separations Process	WT-09-01	1.2.2.5
ID-2.1.16	Decontamination Facility/Analytical Facility Waste Reduction	ID-HLW-101	A9508	Decon Process Waste Volume Reduction	WT-04-01	1.4
			A9264	Improve Waste Analytical Methods	WT-11-01	1.1.3
ID-2.1.17	Develop New Filter Leach Process	ID-HLW-101	A9508	Decon Process Waste Volume Reduction	WT-04-01	1.4
ID-2.1.20	Tank Annulus/Vault Inspection	ID-HLW-105	AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
			A9175	Tank Integrity Inspection Techniques	WT-03-01	1.1.1.1
ID-2.1.23	Low-Activity Wasteform Qualification	ID-HLW-103	A9719	Conditioning and Immobilization of Low-Activity Waste	WT-07-01	1.2.3.1
ID-2.1.24	Integration/Optimization of High Activity Waste/Low Activity Waste Process Flowsheet	ID-HLW-103	A9709	Waste Treatment Process Flowsheet Model	WT-06-01	1.2.2.6
ID-2.1.26	Direct Tank Sampler for Tank Solution Characterization	ID-HLW-101	A9246	Waste Sampling and At-Tank Analysis	WT-01-01	1.1.3

Table B.2. (contd)

Site Need ID	Need Title	PBS#	TFA MYTR#	RespTitle	WP#	PE#
ID-2.1.27	Blowback Metal Filters for Solids (Calcine) Retrieval	ID-HLW-103	A9171	Alternative Air Filtration Technology	WT-04-01	1.1.2
ID-2.1.28	Cs and Sr Removal from Newly Generated Liquid Waste	ID-HLW-103	A9570	Salt Disposition	WT-09-01	1.2.2.5
			A9719	Conditioning and Immobilization of Low-Activity Waste	WT-07-01	1.2.3.1
ID-2.1.29	Evaluate Chloride Corrosion Potential (LET&D/PEWE/Future Processes)	ID-HLW-101	A9514	Removal of Chloride from Waste Solutions	WT-11-01	1.1.4
ID-2.1.30	Remove/Treat Chlorides (LET&D/PEWE/Future Processes)	ID-HLW-101	A9514	Removal of Chloride from Waste Solutions	WT-11-01	1.1.4
ID-2.1.35	Direct Immobilization of INTEC Sodium-Bearing and Newly Generated Liquid Wastes	ID-HLW-103	A9719	Conditioning and Immobilization of Low-Activity Waste	WT-07-01	1.2.3.1
ID-2.1.36	Mercury Removal from Liquid Wastes	ID-HLW-101	A9518	Mercury Removal from Waste Solutions	WT-11-01	1.1.4
ID-2.1.38	Conditioning of Low Activity Waste for Treatment	ID-HLW-103	A9719	Conditioning and Immobilization of Low-Activity Waste	WT-07-01	1.2.3.1
ID-2.1.39	Acceptance Criteria for LAW Disposal in Underground Storage Tanks	ID-HLW-103	A9924	Tank Closure Criteria/Decision Support	WT-05-01	1.3.1
ID-2.1.40	Low Activity Waste Grout Sorbent Addition to Reduce Leachability	ID-HLW-103	A9719	Conditioning and Immobilization of Low-Activity Waste	WT-07-01	1.2.3.1
ID-2.1.42	Acceptance Criteria for Tank Closure	ID-HLW-105	A9924	Tank Closure Criteria/Decision Support	WT-05-01	1.3.1
ID-2.1.43	Certify LDUA Sampler as EPA-Approved Method of Sampling Tank Heel Liquids	ID-HLW-103, ID-HLW-105	A9246	Waste Sampling and At-Tank Analysis	WT-01-01	1.1.3
ID-2.1.44	Certify LDUA Sampler as EPA-Approved Method of Sampling Tank Heel Solids	ID-HLW-103, ID-HLW-105	A9246	Waste Sampling and At-Tank Analysis	WT-01-01	1.1.3
ID-2.1.45	Acceptance Criteria for Grouting Tank Heels	ID-HLW-103	A9924	Tank Closure Criteria/Decision Support	WT-05-01	1.3.1
ID-2.1.46	Management of Tank Heel Liquids	ID-HLW-105	A9923	Enhanced Grout Formulations for Tank Closure	WT-05-01	1.3.1
ID-2.1.47	Management of Tank Heel Solids	ID-HLW-105	A9923	Enhanced Grout Formulations for Tank Closure	WT-05-01	1.3.1
ID-2.1.48	Wasteform Qualification for Low-Activity Waste in Underground Storage Tanks	ID-HLW-103	A9924	Tank Closure Criteria/Decision Support	WT-05-01	1.3.1
ID-2.1.50	Solids Waste (Calcine) Retrieval	ID-HLW-103	A9331	Dry Solid Waste Retrieval	WT-02-01	1.2.1.2
ID-2.1.51	Develop Calcine Dissolution Kinetics for Solid/Liquid Equilibria	ID-HLW-103	A9532	Calcine Dissolution Solubility and Kinetics	WT-11-01	1.2.2.2
ID-2.1.52	Characterization of Solids from Calcine Dissolution	ID-HLW-103	A9532	Calcine Dissolution Solubility and Kinetics	WT-11-01	1.2.2.2
ID-2.1.56	Mercury Treatment for Aluminum Calcine	ID-HLW-103	A9501	INEEL Integrated Radionuclide Separations Process	WT-09-01	1.2.2.5
			A9518	Mercury Removal from Waste Solutions	WT-11-01	1.1.4

Table B.2. (contd)

Site Need ID	Need Title	PBS#	TFA MYTR#	RespTitle	WP#	PE#
ID-2.1.57	Conditioning of HAW for Treatment	ID-HLW-103	A9768	Specify and Enhance Design of HLW Glass Melters	WT-06-01	1.2.3.2
			AA7S2	New Melter Technology	WT-06-01	
ID-2.1.58	HAW Immobilization	ID-HLW-103	A9773	Improve Waste Loading in HLW Glass	WT-06-01	1.2.3.2
			AA7S2	New Melter Technology	WT-06-01	
			AA7S1	Durability of Multiphase Waste Glasses	WT-07-01	
			A9768	Specify and Enhance Design of HLW Glass Melters	WT-06-01	
ID-2.1.62	Acceptance Criteria for Bin Set Closure	ID-HLW-103	A9924	Tank Closure Criteria/Decision Support	WT-05-01	1.3.1
ID-2.1.64	Solid-Liquid Separation Equipment Development and Application	ID-HLW-103	A9584	Cross-Flow Filtration	WT-08-01	1.2.2.4
ID-2.1.65	Treatment/Disposition of Removed Tank Solids	ID-HLW-103	A9709	Waste Treatment Process Flowsheet Model	WT-06-01	1.2.2.6
ID-2.1.66	Treatment/Disposition of Spent Ion Exchange Resins	ID-HLW-103	A9773	Improve Waste Loading in HLW Glass	WT-06-01	1.2.3.2
			AA7S2	New Melter Technology	WT-06-01	1.2.3.2
			A9719	Conditioning and Immobilization of Low-Activity Waste	WT-07-01	1.2.3.1
			A9768	Specify and Enhance Design of HLW Glass Melters	WT-06-01	1.2.3.2
			AA7S1	Durability of Multiphase Waste Glasses	WT-07-01	1.2.3.2
ID-2.1.67	High Level Waste Slurry Handling	ID-HLW-103	A9365	Waste Transfer Pumping	WT-02-01	1.2.1.4
			A9278	Slurry Transfer and Tank Waste Mixing Monitors	WT-08-01	1.1.3
			A9361	Heel Retrieval from Obstructed Tanks	WT-03-01	1.2.1.2
ID-2.1.68	Technetium Removal from INEEL High Level Waste	ID-HLW-101	A9501	INEEL Integrated Radionuclide Separations Process	WT-09-01	1.2.2.5
ID-2.1.69	Solids Waste (Calcine) Retrieval from CSSF1	ID-HLW-103	A9331	Dry Solid Waste Retrieval	WT-02-01	1.2.1.2
ID-2.1.71	Grout/Heel Mix in Place System	ID-HLW-103	A9985	Demonstration of Grout Injection Technology for Tank Closure	WT-05-01	1.3.1
ID-2.1.72	Alternate Heel Sampling Systems	ID-HLW-103	AA203	Residual Waste Sampling	WT-02-01	1.1.3
			AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
OAK RIDGE RESERVATION						
ORTK-01	Tank Waste Characterization	OR-151	A9175	Tank Integrity Inspection Techniques	WT-03-01	1.1.1.1
			A9143	HLW Tank Corrosion Control and Monitoring	WT-04-01	1.1.1.1
			AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1

Table B.2. (contd)

Site Need ID	Need Title	PBS#	TFA MYTR#	RespTitle	WP#	PE#
ORT K-02	Tank Solid Waste Retieval	OR-321	AA3S2	SST Retrieval from Potential Leaking Tanks	WT-03-01	1.2.1.2
			A9359	Waste Mixing and Retrieval	WT-02-01	
			A9367	Unobstructed Tank Heel Retrieval	WT-03-01	
			A9382	Horizontal and Small Tank Sludge Mixing and Retrieval	WT-02-01	
ORTK-04	Sludge Mixing and Slurry Transport	OR-321	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
			A9554	Hanford Tank Waste Chemistry	WT-08-01	1.2.2.3
			A9278	Slurry Transfer and Tank Waste Mixing Monitors	WT-08-01	1.1.3
ORTK-05	Tank Sludge and Supernatant Separations	OR-151, OR-311	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
ORTK-05	Tank Sludge and Supernatant Separations	OR-151, OR-311	AA5S1	Removal of Key Non-Radioactive Elements from Tank Waste	WT-08-01	1.2.2.7
ORTK-05	Tank Sludge and Supernatant Separations	OR-151, OR-311	A9555	Sludge Washing and Dissolution	WT-08-01	1.2.2.7
ORTK-05	Tank Sludge and Supernatant Separations	OR-151, OR-311	A9586	CIF Evaporator	WT-09-01	1.1.4
ORTK-06	Tank Sludge Supernatant Immobilization	OR-151, OR-311	A9719	Conditioning and Immobilization of Low-Activity Waste	WT-07-01	1.2.3.1
ORTK-09	Tank Closure	OR-321	A9985	Demonstration of Grout Injection Technology for Tank Closure	WT-05-01	1.3.1
			A9923	Enhanced Grout Formulations for Tank Closure	WT-05-01	
ORTK-11	Tank Supernatant Pretreatment	OR-311	A9570	Salt Disposition	WT-09-01	1.2.2.5
			A9586	CIF Evaporator	WT-09-01	1.1.4
SAVANNAH RIVER SITE						
SR00-1011	Demonstrate Evaporation Technologies to Reduce Generation of Secondary Waste Volume from Consolidated Incineration Facility	SR-SW01	A9586	CIF Evaporator	WT-09-01	1.1.4
SR00-2027	Demonstrate Alternative Filtration Technologies to Replace HEPA Filters	SR-HL01, SR-HL02	A9171	Alternative Air Filtration Technology	WT-04-01	1.1.2
SR00-2028	Alternative Waste Removal Technology	SR-HL01, SR-HL02, SR-HL03	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
SR00-2028	Alternative Waste Removal Technology	SR-HL01, SR-HL02, SR-HL03	A9362	Salt Cake Dissolution Retrieval	WT-02-01	
SR00-2028	Alternative Waste Removal Technology	SR-HL01, SR-HL02, SR-HL03	A9359	Waste Mixing and Retrieval	WT-02-01	

Table B.2. (contd)

Site Need ID	Need Title	PBS#	TFA MYTR#	RespTitle	WP#	PE#
SR00-2028	Alternative Waste Removal Technology	SR-HL01, SR-HL02, SR-HL03	AA3S2	SST Retrieval from Potential Leaking Tanks	WT-03-01	
SR00-2029	Alternate DWPF Canister Decon Technology	SR-HL05	A9772	Alternative HLW Canister Decontamination Techniques	WT-07-01	1.4
SR00-2031	Develop Remote Technology to Improve DWPF Operations	SR-HL05	A9374	Remote Technologies for Process Cell Operations and Maintenance	WT-10-01	1.4
SR00-2032	Optimize Melter Glass Chemistry and Increase Waste Loading	SR-HL05	AA7S1	Durability of Multiphase Waste Glasses	WT-07-01	1.2.3.2
			A9773	Improve Waste Loading in HLW Glass	WT-06-01	
			AA7S2	New Melter Technology	WT-06-01	
SR00-2033	Provide Alternative Processing and/or Concentration Methods for DWPF Recycle Aqueous Streams	SR-HL01, SR-HL02, SR-HL05	A9566	Vitrification Recycle	WT-11-01	1.1.4
SR00-2034	Second Generation Salt Feed Preparation	SR-HL13	A9570	Salt Disposition	WT-09-01	1.2.2.5
			A9579	Tetraphenylborate Process for Cesium Separations		
			A9580	Actinide Separations Using Mono Sodium Titanate		
SR00-2035	Develop Advanced Techniques for Life Extension of High Level Waste Tanks and Piping	SR-HL01, SR-HL02, SR-HL03	A9175	Tank Integrity Inspection Techniques	WT-03-01	1.1.1.1
SR00-2035	Develop Advanced Techniques for Life Extension of High Level Waste Tanks and Piping	SR-HL01, SR-HL02, SR-HL03	AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
SR00-2036	Develop Improved HLW Melter	SR-HL05	AA7S1	Durability of Multiphase Waste Glasses	WT-07-01	1.2.3.2
			A9773	Improve Waste Loading in HLW Glass	WT-06-01	
			AA7S2	New Melter Technology	WT-06-01	
			A9768	Specify and Enhance Design of HLW Glass Melters	WT-06-01	
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	A9157	Tank Leak Mitigation	WT-03-01	1.2.1.5
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	A9365	Waste Transfer Pumping	WT-02-01	1.2.1.4
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	A9363	Chemical Cleaning of Tanks	WT-05-01	1.2.1.2
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	A9278	Slurry Transfer and Tank Waste Mixing Monitors	WT-08-01	1.1.3
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	A9382	Horizontal and Small Tank Sludge Mixing and Retrieval	WT-02-01	1.2.1.2
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	AA3S2	SST Retrieval from Potential Leaking Tanks	WT-03-01	1.2.1.2

Table B.2. (contd)

Site Need ID	Need Title	PBS#	TFA MYTR#	RespTitle	WP#	PE#
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	A9359	Waste Mixing and Retrieval	WT-02-01	1.2.1.2
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	A9554	Hanford Tank Waste Chemistry	WT-08-01	1.2.2.3
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	AA303	Waste Retrieval from Confined Spaces	WT-12-01	1.2.1.2
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	A9175	Tank Integrity Inspection Techniques	WT-03-01	1.1.1.1
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	A9352	Remote Systems for Pit Operations and Maintenance	WT-04-01	1.4
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	AA203	Residual Waste Sampling	WT-02-01	1.1.3
SR00-2037	Tank Heel Removal/Closure Technology	SR-HL01, SR-HL02, SR-hl03	A9367	Unobstructed Tank Heel Retrieval	WT-03-01	1.2.1.2
SR00-2039	Methods to Unplug Waste Transfer Lines	SR-HL01, SR-HL02, SR-HL03	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
SR00-2039	Methods to Unplug Waste Transfer Lines	SR-HL01, SR-HL02, SR-HL03	A9554	Hanford Tank Waste Chemistry	WT-08-01	1.2.2.3
SR00-2039	Methods to Unplug Waste Transfer Lines	SR-HL01, SR-HL02, SR-HL03	A9376	Waste Transfer Line Plugging Prevention and Unplugging Methods	WT-01-01	1.2.1.4
SR00-2040	Demonstrate Remote Decommissioning and Disassembly of High Level Waste Processing Equipment	SR-HL05	A9777	Remote Disassembly of HLW Melters and Other Processing Equipment	WT-06-01	1.4
SR00-2041	Develop Advanced Mixing Technology	SR-HL01, SR-HL02, SR-HL03	A9359	Waste Mixing and Retrieval	WT-02-01	1.2.1.2
SR00-2044	In-Situ Technology for Waste Characterization	SR-HL01, SR-HL02, SR-HL03	AA202	In-Situ Waste Characterization	WT-02-01	1.1.3
SR00-2044	In-Situ Technology for Waste Characterization	SR-HL01, SR-HL02, SR-HL03	AA201	Sludge Mapping and Volume Estimates	WT-11-01	1.1.3
SR00-2044	In-Situ Technology for Waste Characterization	SR-HL01, SR-HL02, SR-HL03	A9278	Slurry Transfer and Tank Waste Mixing Monitors	WT-08-01	1.1.3

Table B.2. (contd)

Site Need ID	Need Title	PBS#	TFA MYTR#	RespTitle	WP#	PE#
SR00-2045	In-Situ Waste Tank Corrosion Probe	SR-HL01, SR-HL02, SR-HL03	A9143	HLW Tank Corrosion Control and Monitoring	WT-04-01	1.1.1.1
SR00-2051	Technology to Mitigate Effects of Technetium Under Tank Closure Conditions	SR-HL03	A9588	Leaching and Treatment of Technetium for Tank Closure	WT-05-01	1.3.1
			A9960	Sequestering of Contaminant Migration		
SR00-2052	Aluminum Dissolution from HAW Sludge and Its Impact on Downstream Salt Processing	SR-HL02, SR-HL05	A9555	Sludge Washing and Dissolution	WT-08-01	1.2.2.7
SR00-2052	Aluminum Dissolution from HAW Sludge and Its Impact on Downstream Salt Processing	SR-HL02, SR-HL05	AA5S1	Removal of Key Non-Radioactive Elements from Tank Waste	WT-08-01	1.2.2.7
SR00-2052	Aluminum Dissolution from HAW Sludge and Its Impact on Downstream Salt Processing	SR-HL02, SR-HL05	AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	WT-05-01	1.2.1.2
SR00-2055	Increase in Applicability/Efficiency of High-Level Waste Planning Tool	SR-HL05	A9709	Waste Treatment Process Flowsheet Model	WT-06-01	1.2.2.6
SR00-3022	In-Situ Grouting and/or Retrieval of Waste from Underground Tanks (Formerly Used for the Storage of Radioactive Solvents)	SR-ER02	A9985	Demonstration of Grout Injection Technology for Tank Closure	WT-05-01	1.3.1
			A9923	Enhanced Grout Formulations for Tank Closure		
SR00-2053-S	Develop an Alternative Sorbent to Replace Monosodium Titanate for Sr and Actinide Removal	SR-HL01, SR-HL02	A9580	Actinide Separations Using Mono Sodium Titanate	WT-09-01	1.2.2.5
SR00-2054-S	Develop Improved Radiochemical Analysis for High Ionic Strength Samples	SR-HL01, SR-HL02	A9264	Improve Waste Analytical Methods	WT-11-01	1.1.3
WEST VALLEY DEMONSTRATION PROJECT						
OH-WV-902	Decontamination of High-Level Waste (HLW) Canisters (WVDP-2-99)	OH-WV-02	A9772	Alternative HLW Canister Decontamination Techniques	WT-07-01	1.4
OH-WV-903	Vitrification Expended Material Processing (WVDP-3-99)	OH-WV-04	A9777	Remote Disassembly of HLW Melters and Other Processing Equipment	WT-06-01	1.4
OH-WV-904	High Level Waste Tank Closure	OH-WV-01	AA310	Tank Decontamination and Dismantling	WT-12-01	1.4
			A9985	Demonstration of Grout Injection Technology for Tank Closure	WT-05-01	1.3.1
OH-WV-905	Retrieval of Tank Heels	OH-WV-01	A9382	Horizontal and Small Tank Sludge Mixing and Retrieval	WT-02-01	1.2.1.2
			A9361	Heel Retrieval from Obstructed Tanks	WT-03-01	
OH-WV-906	Radioactivity Measurement of High-Level Waste Tank Residuals	OH-WV-01	AA202	In-Situ Waste Characterization	WT-02-01	1.1.3
OH-WV-907	High-Level Waste Tank Interim Maintenance	OH-WV-01	A9175	Tank Integrity Inspection Techniques	WT-03-01	1.1.1.1
			AA1S1	Pre-Closure Interim Tank Maintenance	WT-05-01	1.1.1
OH-WV-914	Development of Grout for In-Situ Closure	OH-WV-01	A9923	Enhanced Grout Formulations for Tank Closure	WT-05-01	1.3.1

Appendix C

Prioritization Process

Appendix C

Prioritization Process

Each fiscal year, the Tanks Focus Area (TFA) reviews its prioritization process and amends it according to any changes in programmatic requirements, such as changes in strategic and tactical approaches. Amendments to the prioritization process must be approved by the TFA's user community. Therefore, this appendix describes the process used in FY00. Modifications to this process may occur as the TFA works with its users to execute the program development activities scheduled in FY01.

C.1 Program Development Process

The TFA's prioritization process is but one component of the overall program development process. The entire program development process will be summarized here to provide a more comprehensive understanding of the prioritization process in a user-driven technology development program. The major program development steps are shown in Figure C.1.

The TFA accomplishes its objective by executing an iterative approach to program development that involves site users and stakeholders through the STCGs at each site. The needs assessment forms the basis for TFA program definition. As previously noted, the TFA's program development cycle begins with the collection of site needs and ends with the publication of the MYPP. The Site Needs Assessment describes the TFA's efforts through the first part of this cycle, from site needs collection through the

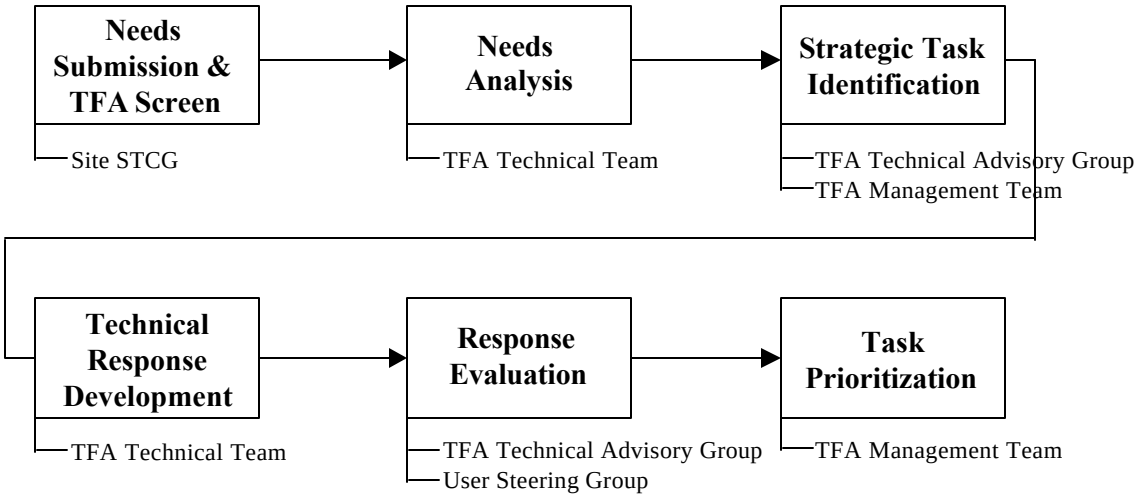

Figure C.1. FY00 Tanks Focus Area Technical Response Development Process

development of technical responses and their initial prioritization. The TFA uses six steps to accomplish the first part of this cycle, which are listed below and depicted in Figure C.1:

- STCG needs submission and TFA screen
- Needs analysis
- Strategic task identification
- Technical response development
- Response evaluation
- TFA Management Team prioritization.

C.2 STCG Needs Submission and TFA Screen

The tank waste sites submitted their science and technology development needs from October through December 1999. Each site uses its own internal process to determine and prioritize site needs as necessary. The standardized site needs template again proved helpful in communicating and understanding the needs. The TFA's Site Representatives were essential in communicating the needs from the sites to the TFA. (See Figure C.2, Tanks Focus Area Organization.) This year, the sites, in general, communicated their science and technology needs statements earlier than in any previous year.

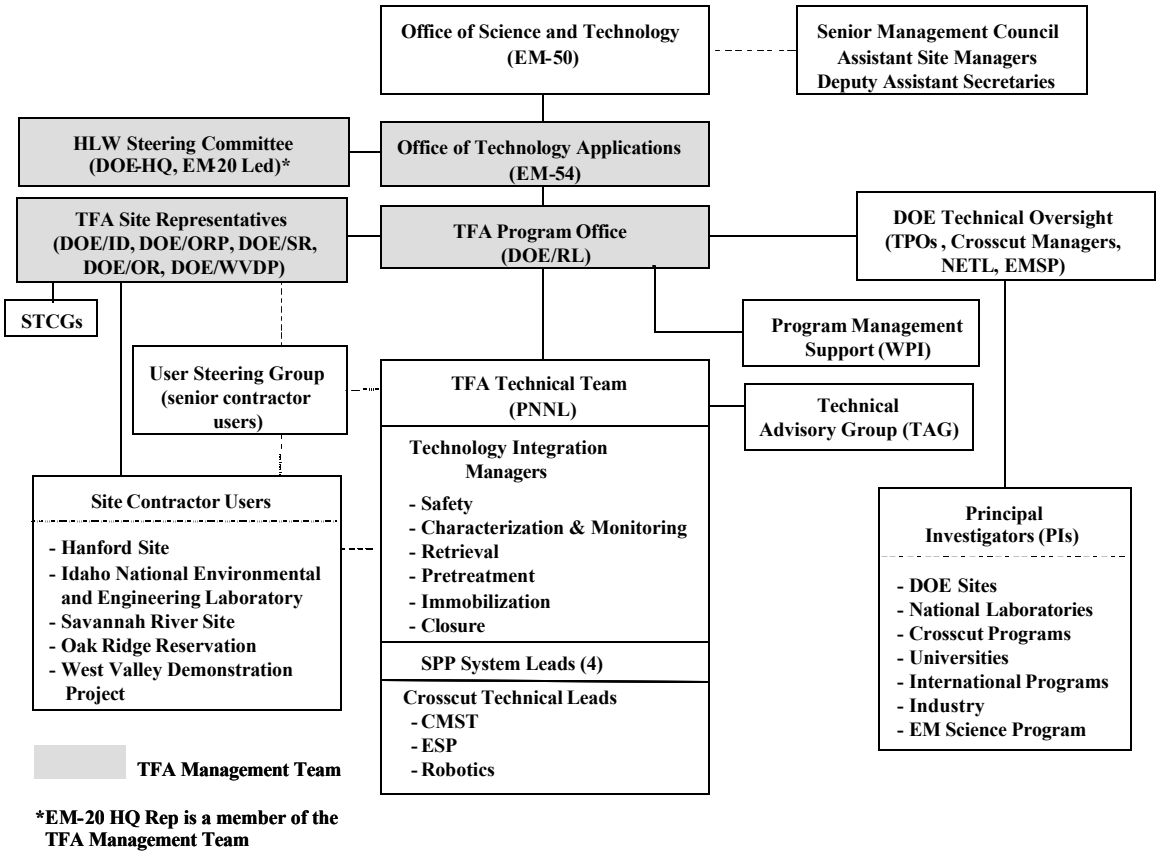

Figure C.2. Tanks Focus Area Organization

The TFA appreciated these earlier submissions, which provided additional time to integrate the information with other OST program activities.

Each need was subjected to an initial needs screening. The screening assessed whether or not the need and possible technical response

- was within the TFA mission area
- required a research and development component
  - development, first-time hot demonstration or deployment, re-engineering, etc., was required
  - technology was available, and no technology development was required
- was technically feasible (schedule or cost are included in the assessment).

C.3 Needs Analysis

The TFA analyzed each site need that passed through the screening criteria, to fully understand the technical basis and site intent behind the needs. The TFA worked interactively with the sites to better understand the problem to be solved, required performance specifications, timing of the technical solution, integration of functional interfaces (e.g., between pretreatment and immobilization), and interfaces with other OST programs.

C.4 Strategic Task Identification

Focusing predominately on the analysis of site-submitted needs, the TFA identified needs whose solutions would be strategic in nature to the TFA. Additionally, the TFA identified technology "gaps" that became apparent in the needs analysis, or that were identified through other TFA processes, such as technology interface workshops. The TFA Technical Advisory Group (TAG) provided advice and guidance on the identification and scope of proposed strategic tasks. The TFA submitted these issues for consideration and review by its Management Team. The Management Team either voiced no objection to the development of a technical response to issues included within the TFA list of needs, or determined that the issue merited no further TFA consideration.

The TFA developed and refined its own definition of a strategic task. The following points define a TFA strategic task:

- Pursues a problem identified within a site baseline, but not currently being addressed. This problem would be long-term and may otherwise go unsatisfied due to budget limitations and priority. An official need may or may not have been submitted by the STCG of a specific site. Successful TFA response to the need may result in
  - accelerated schedule
  - risk reduction (programmatic or technical)
  - establishment of a technical or programmatic basis that drives near-term related baseline efforts.

- Resolves a recently identified technical roadblock or problem. This problem may be near- or long-term in nature, and may or may not be associated with baseline technologies or flowsheets. This

problem may be identified by the TFA or external reviewers, rather than officially submitted as a need by a specific site. Satisfaction of this need may result in
  - prevention of recently identified problems
  - technical contingency through identification of another viable technical approach
  - risk reduction (programmatic or technical).

- Effects a change (alternative) to a baseline. The problem could be near-term and may require that the TFA leverage other programs. An official need may or may not have been submitted by a site. Successful response to the need may result in
  - mortgage reduction
  - risk reduction (programmatic or technical).

The TFA secured wide user support for the concept of selective identification and funding of strategic tasks, and, as a result, is pursuing five strategic tasks in FY01.

C.5 Technical Response Development

The TFA developed technical responses to all needs passing through the screening criteria. Those needs screened out were coordinated with the submitting site for further disposition. Some needs were screened out as potentially outside of the TFA mission area. These needs may best be addressed within a different OST program, such as another focus area. In such cases, the TFA interacts with the other programs and informs the submitting site STCG of any need identified as such in this process.

The responses were prepared by the Technical Team (see Figure C.2) and submitted to the TAG, USG, and Management Team for review and comment. To the maximum extent possible, the TFA integrated responses to similar needs. Also, the TFA was careful to take advantage of other OST funding sources to maximize leveraging opportunities.

The TFA uses an established standard framework to begin its annual program planning process. This framework groups similar or related site needs and the TFA's technical responses, allowing for technical integration across functions to solve specific problems, as opposed to consolidating needs by technical focus. This activity begins the transition from needs collection and analysis to TFA program development. The results of the program development process provide the basis for the MYPP.

To establish and maintain this program planning framework, the TFA uses its problem element structure. The problem elements

- provide an updated method to logically group site needs and TFA technical responses
- assist in sequencing and scheduling integrated technical solutions
- identify the problem elements and the needs within them as baseline, enhancements, or alternatives.

The TFA problem element structure appears in Table C.3.

Table C.3. Problem Element Structure

PE#	Problem Element
1.1	Store Waste
1.1.1	Extend Tank Life
1.1.1.1	Monitor Tank Integrity/Avoid 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
1.2.1.4	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
1.2.1.8	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 and Control Pretreatment Process
1.2.3	Immobilize Waste
1.2.3.1	Process LLW
1.2.3.1.1	Monitor and 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 and 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 LLW 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
1.3.3.3	Monitor HLW for Acceptance
1.4	Decontamination and Decommissioning

C.6 Technical Response Rating

The TFA rated each technical response for use in prioritization activities that are essential for program funding decisions. The TFA assembled for its Management Team's consideration, rating factors relevant to the prioritization activities. These rating factors aligned with the criteria used by the Management Team's program prioritization. The criteria included the following:

- Broad-based benefit
- User commitment to deploy
- Technical risk
- Other technology impact.

Broad-Based Benefit - This criterion addressed the potential complex-wide benefit of a technical response.

High: *Two* or more different site STCG-submitted needs with strong interest in a single, integrated response. Note: "strong interest" means site interest is confirmed with the TFA Site Representative and USG member.

High to Medium:

- High/Medium: One STCG-submitted need; two or more sites with strong interest where resulting hardware or data would *directly* benefit.
- Medium/High: One STCG-submitted need; one site with strong interest where resulting hardware or data would *directly* benefit.
- Medium: One STCG-submitted need; one site with strong interest where resulting hardware or data would *indirectly* benefit; or one STCG-submitted need that may be satisfied through deployment of a technology already developed elsewhere, but still requiring technology development work.

Low: One STCG-submitted need and one other potential benefiting site based on Technology Integration Manager (TIM) judgment.

User Commitment - The TFA values user commitment to the development and deployment of technical solutions. This criterion assesses the strength of user commitment to share the burden of a technology's development and deployment.

High:

- Site co-funds development and demonstration (or deployment)
- High commitment to deploy through out-year baseline, PBS, and budget request; memorandum of understanding (MOU) or other signed document for TFA next year expenditures over $1M
- Currently in site baseline operational plan with MOU or other signed document committing to funding and plan for deployment in subject FY

- Deployment within 1 - 2 years
- Greater than or equal to 50/50 co-funding of development and demonstration for the year of prioritization and duration of the response.

High/Medium: Response results in data delivery for key DOE decisions, e.g., Environmental Impact Statement (EIS) or privatization decisions.

- Site co-funds data development and delivery
- Data will be used within 1 - 2 years
- High commitment to deploy through out-year baseline, PBS, and budget request; MOU or other signed document for TFA expenditures over $1M
- Greater than or equal to 50/50 co-funding of development and delivery for the year of prioritization and duration of the technical response.

Medium/High: Approximately equal co-funding to develop and demonstrate during time of the technical response. High commitment to deploy through out-year baseline, PBS, and budget request; TFA Site Representative commitment to obtain MOU or other signed document for TFA next year expenditures over $1M.

Medium: Approximately one-quarter co-funding; high commitment to deploy through out-year baseline, PBS, and budget request; TFA Site Representative commitment to obtain MOU or other signed document for TFA next year expenditures over $1M.

Low: Site co-funding exists, but no commitment to deploy or use data (e.g., not in sites' out-year planning documents).

Note on co-funding: Co-funding is to be focused on support to the overall project the TFA is funding. This may include direct support to the Principal Investigator (PI), support to on-site operations staff to facilitate testing, sample collection/analysis/shipping, design, and review(s). Also the TFA Management Team may require a MOU or some other documented user commitment on any task under consideration for TFA funding.

Technical Risk - This criterion considers technical risks related to site baselines.

Needs Priority

- High: Technical response addresses at least two needs with a priority of 1, or three needs with a priority of 2.
- Medium: Technical response addresses at least one need with a priority of 1, or two needs with a priority of 2.
- Low: Technical response addresses at least one need with a priority of 2. (Note: no value is assigned to a technical response addressing needs with a priority of 3.)

Technical Risk

- High: Related waste stream technical risk is high (risk rating of 4 or 5), or related critical path milestone technical risk is high (risk rating of 4 or 5)

- Medium: Related waste stream technical risk is medium (risk rating of 3), or related critical path milestone technical risk is medium (risk rating of 3)
- Low: Related waste stream technology risk is medium or low (risk rating of 2 or 1), or related critical path milestone technical risk is medium or low (risk rating of 2 or 1).

Other Technology Impact - The objective of this criterion is to broadly assess the overall potential technology impact of a technical response. The TFA considers a response's impact on schedule, cost avoidance, and link to regulatory requirements to determine impact. The ratings include the following:

High: (one or more of the following apply)

- Technology required to meet baseline assumptions
- Documented high cost avoidance (over $250M) to EM (information must be provided to TFA by site with uncertainty analysis)
- Possesses high cost reduction potential (over $250M)
- Technical response is required to meet firm regulatory requirements that could delay tank waste remediation schedules.

Medium: (one or more of the following apply)

- Required to meet enhancements or alternatives to baseline
- Documented moderate cost avoidance (between $250M and $50M) to EM or general consensus on high cost avoidance (over $250M) that cannot be documented due to lack of data that will be developed if the task goes forward
- Possesses moderate cost reduction potential
- Adds assurance that regulatory requirements are met, or supports a regulatory requirement that the site may renegotiate.

Low: (one or more of the following)

- Appears that technology could meet baseline or enhancement assumptions, but more data is needed and will be provided explicitly if the task proceeds
- General consensus that moderate cost avoidance (between $250M and $50M) could be achieved but cannot yet be documented
- Technical response's link to regulatory requirements is not fully determined.

In March 2000, the TFA evaluated each technical response using the approved criteria. This initial assessment was accomplished in a group consensus of TIMs, monitored by the TFA Management Team. The TFA's intent was to ensure that technical responses would

- be provided for each need received
- contain an explanation of the priority of the response according to either
  - screening criteria
  - prioritization criteria
- describe multiyear intent

- 4-year budget estimate (current + 3 years)
- basis of estimate

- describe the intended scope (2 to 3 paragraphs)
- identify the relationship or benefit to other site needs.

C.7 TFA Management Team Prioritization

The TFA technical response prioritization took place on March 9, 2000, in conjunction with TFA Midyear activities. During prioritization, the TFA Management Team assigned final scores to each technical response against the approved criteria. The Management Team discussed the merits of the responses, focusing closely on aspects of site benefits, user commitment, and continuity of ongoing technology development. Additionally, the Management Team reviewed and approved six strategic tasks for inclusion into the FY01-02 program. At the conclusion of the prioritization session, the Management Team affirmed the results, thereby creating the official TFA FY01-02 Integrated Priority Listing (IPL).

The final version of the FY01 technical responses are posted on the TFA Technical Team website at http://www.pnl.gov/tfa/program/index.stm.

C.8 Data Summary

In all, the TFA received 140 science and technology needs. The TFA assigned each need to one of the TFA's six functional areas based on the major subject area of the need. Some needs statements were broad enough that they required action in more than one technical response. In all, 63 technical responses were prepared by the TFA. A summary of the TFA's functional assignment of needs and technical responses by site is shown in Table C.4.

Table C.4. Summary of Site Needs Submitted to the Tanks Focus Area

	Hanford	INEEL	ORR	SRS	WVDP	Total
Safety	7	2	1	3	1	14
Characterization	10	7	0	2	1	20
Pretreatment	12	14	3	7	0	36
Immobilization	6	11	1	5	1	24
Retrieval	8	4	1	7	2	22
Closure	13	7	1	0	3	24
Total	56	45	7	24	8	140

The needs across the complex reflect requirements to perform the following activities:

- Inspect tank integrity, monitor tank corrosion, and detect and mitigate leaks
- Reduce waste volumes and minimize the generation of additional wastes, including secondary wastes
- Sample and characterize the chemical and physical properties of the wastes
- Retrieve salt and sludge wastes and tank heels
- Pump and transfer wastes efficiently without plugging pipelines
- Separate radionuclides from non-radioactive waste components

- Provide grout and glass waste forms for LLW immobilization and disposal
- Optimize waste loadings in glass waste forms
- Enhance design of HLW glass melters
- Improve efficiency of existing waste storage and treatment facilities operations and maintenance
- Access waste residuals as precursors to additional retrieval and tank closure decisions
- Immobilize waste residuals and stabilize tanks as part of closure.

Hanford and SRS require continued emphasis on determining the impacts of waste chemistry on waste retrieval and transport. Hanford and SRS require additional mixing technologies to suspend sludges and saltcake for waste removal. SRS requires technical data to support the selection, design, and implementation of an alternative salt processing technology for radionuclide removal. As waste storage and processing facilities mature, technologies are needed for remote maintenance and repair and to optimize equipment design for improved operations. INEEL needs technical data to support process selection and design for liquid and calcine waste treatment. WVDP and SRS require improved technologies for HLW canister decontamination. Hanford needs additional data and tools to support waste disposal system performance assessments.

During its analysis of the site needs, the TFA found that many of the requirements from any one site have multi-site benefit. The TFA will exploit the resolution of these requirements to leverage multi-site benefit. Multi-site benefit is one of the four criteria the TFA used this year in prioritizing future work. The program for FY01 - FY02 reflects the importance the TFA places on multi-site benefit.

C.9 Present Program Prioritization

The prioritization process serves at least three purposes for the TFA. First, it fine-tunes the program scheduled for execution in the upcoming fiscal year. Second, it forms the basis for development of the Corporate Review Budget (CRB) supporting the year following the upcoming fiscal year. Third, it begins to define the program for the three years following the CRB year. The TFA's prioritized multi-year response listing for FY01-FY02 appears in Appendix B.

Appendix D

Major Milestones

Appendix D

Major Milestones

Delivery of solutions to address site needs is a critical success measure of the TFA investments for solving EM problems. The nature of those problems and the technical solutions and schedules are discussed in Sections 1 and 5. To monitor progress toward technical objectives and increase probability of success, major milestones that represent significant progress, accomplishments, or interim steps towards delivery of technical solutions are identified from the overall list of program milestones. Progress toward delivery of solutions is measured in three areas:

- Delivery of data to support key decisions and to fill gaps in technical knowledge required to define the path to solution.
- Demonstration of technologies or concepts to support selection of technology alternatives or to demonstrate progress towards deployment of selected technologies.
- Deployment of technical solutions, including implementation of data in a baseline program and actual installation and operation of technologies in a tank, tank complex, or waste treatment facility.

Program guidance and technical task plans, including milestones, are developed to guide the evolution of the work and to measure progress at appropriate points in the implementation of the workscope. From those overall program milestones, a subset of key milestones is selected that represents critical activities, demonstrations, or deployments indicating significant progress toward or completion of delivering a technical solution. These key performance indicators and expected performance for each activity are defined in more detail in the Annual Performance Plan (submitted at the start of the current execution year). Key activities and milestones are summarized in Table D.1. These activities are prioritized for funding in the TFA FY01 target budget case, but the table does not reflect funded projects impacted by fiscal year budget holds or reductions. In addition, these activities are based on the multiyear responses and may change based on final TTP negotiations.

Table D.1. Key Activities and Milestones

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
Tank Waste Retrieval & Closure						
	WT-01-01	Transfer Line/Unplugging/Feed Analysis	A9246	Waste Sampling and At-Tank Analysis	Demo improved tank waste sampler (INEEL)	01
					Demo prototype mobile fluidic sampler at AEAT (Hanford)	01
					Deploy improved waste sampler with LDUA to obtain tank heel samples (INEEL)	02
			A9376	Waste Transfer Line Plugging Prevention and Unplugging Methods	Demonstrate industry technologies for pipe blockage locating and unplugging (SRS, Hanford)	01
					Demonstrate application of unplugging technology for drain line unplugging (SRS)	02
					Complete Demo of Pipeline Unplugging/Blockage Locating Technology(ies)	03
	WT-02-01	Waste Mobilization and Retrieval	A9331	Dry Solid Waste Retrieval	Demonstrate methods for riser installation and calcine sampling	01
					Deploy riser installation technology for calcine bins (INEEL)	02
					Deploy calcine sampler in storage bins (INEEL)	02
					Demonstrate removal methods for calcine retrieval (INEEL)	02
			A9359	Waste Mixing and Retrieval	Demonstrate alternate technologies to replace mixer pumps (SRS)	01
					Demonstrate technologies for extended sludge retrieval (Hanford)	01
					Demonstrate dynamic mixer modeling with AZ-101 tank data (Hanford)	01

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
					Demonstrate improved mixing and waste pumping technologies for waste retrieval (Hanford & SRS)	02
					Deploy mixer pump operational improvements and Advanced Design Mixer Pump (Hanford, SRS)	02
					Complete Flygt mixer retrieval operations in tank 19	01
					Issue decision to proceed with mixer pump operational improvements in tanks 7 or 11	01
					Complete deployment of mixer pump operational improvement system in tanks 7 or 11	02
			A9362	Salt Cake Dissolution Retrieval	Demonstrate low-volume density gradient concepts for saltcake dissolution retrieval (Hanford)	01
					Demonstrate prototype low-volume saltcake dissolution retrieval technology (Hanford)	02
					Deploy Salt Cake Dissolution Retrieval System (Hanford)	03
			A9365	Waste Transfer Pumping	Demonstrate candidate variable-depth transfer pump technologies (SRS)	01
					Deploy above-ground temporary waste transfer line for Tank 18 (SRS)	02
					Evaluate candidate technologies and issue decision to proceed with acquisition of slurry transfer system (INEEL)	03
					Complete fabrication of telescoping transfer pump (SRS)	03

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
			A9382	Horizontal and Small Tank Sludge Mixing and Retrieval	Demonstrate retrieval tools for small tanks and piping (WV)	01
					Demonstrate options for small tank retrieval (Hanford)	01
					Demonstrate CTS/1F retrieval system (SRS)	02
					Demonstrate small tank and piping retrieval system (WV)	02
					Deploy retrieval system in HFIR Tank	01
					Deploy retrieval system in Tanks T-1 and T-2	01
					Issue recommendation for CTS Pump Tank/1F evaporator retrieval system	01
					Demonstrate pipe and miscellaneous tank cleaning system	01
					Deploy miscellaneous tank cleaning system	02
					Demonstrate CTS pump tank/1F evaporator system	03
					Deploy CTS pump tank/1D evaporator system	03
			AA202	In-Situ Waste Characterization	Deploy survey instruments for tank residual waste surveys (WV)	01
					Demonstrate In-situ tank sensor system	01
					Deploy survey instruments for tank residual waste surveys (WV)	02
					Demonstrate real-time instruments for radionuclide surveys (SRS)	02
			AA203	Residual Waste Sampling	Demonstrate technology for residual waste sampling (INEEL, SRS)	01
					Deploy technology for residual waste sampling (INEEL, SRS)	02

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
	WT-03-01	Tank Integrity and Heel Retrieval	A9175	Tank Integrity Inspection Techniques	Demonstrate TSAFT software program to improve interpretation of DST inspection data (Hanford, EM-40 funded)	01
					Deploy tank inspection and sludge mapping system for MVST (ORNL)	01
					Demo NDE system for SST and DST inspection (Hanford)	02
					Demo remote transfer piping inspection technology at SRS (SRS)	02
					Demo remote inspection technology for annulus inspection of MVST (ORNL)	02
					Demo/deploy small roving annulus inspection vehicle (SRS)	02
					Demo Tank Remote Inspection System (INEEL)	02
					Deploy Remote Tank Repair System (SRS) - FY03	03
					Demo Tank Remote Repair System (SRS)	03
					Deploy Tank Remote Repair System in an SRS Tank	03
					Demo Remotely operated destructive evaluation and repair system in Hanford DST (Hanford)	03
					Deploy Remotely operated destructive evaluation and repair system in Hanford DST (Hanford)	04
					Deploy Tank Remote Inspection System at INEEL (no specific milestone)	04

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
			A9361	Heel Retrieval from Obstructed Tanks	Deploy Sampler in 8D-1 to complete tank retrieval (WV)	01
					Recommend retrieval options for INEEL HLW tank retrieval (INEEL)	01
					Deploy Sampler in 8D-2 to complete tank retrieval (WV)	02
			A9367	Unobstructed Tank Heel Retrieval	Deploy crawler for retrieval of Tank 18 (SRS)	02
					Demonstrate equipment improvements for tank sluicing (Hanford)	02
					Demonstrate SST retrieval system (Hanford)	03
			AA3S2	SST Retrieval from Potential Leaking Tanks	Recommend SST retrieval options and identify technical requirements and issues (Hanford)	01
					Demonstrate selected retrieval technologies for SST retrieval (Hanford)	02
					Recommend retrieval technologies and strategies for SST retrieval (Hanford)	02
	WT-04-01	Ancillary Tank Equipment Enhancements	A9143	HLW Tank Corrosion Control and Monitoring	Complete corrosion probe development and deploy (Hanford, SRS, ORNL)	01
					Complete cold demonstration of EIC probe assembly and associated equipment	01
					Deploy EIC combined corrosion and chemical probe	01
			A9171	Alternative Air Filtration Technology	Deploy Alternative Filtration System (SRS) - Planned Completion	01
					Demonstrate commercial filtration technologies for calcine transport applications (INEEL)	01

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
					Complete full-scale filter element testing	01
					Demonstrate contractor's alternative filtration system	01
					Deploy contractor's alternative filtration system	02
					Demonstrate full-scale filtration system for calcine transport applications (INEEL)	02
					Complete cold demonstration of full-scale alternative filtration system	02
			A9352	Remote Systems for Pit Operations and Maintenance	Deploy first generation remote systems for pit operations enhancements (Hanford)	01
					Demonstrate remote technology enhancements for pit operations (Hanford)	02
					Demonstrate remote technologies for equipment decontamination (SRS)	02
					Deploy Enhanced Remote Pit Operations and Maintenance System (Hanford)	03
					Deploy 299 H Pit System (SRS)	03
			A9508	Decon Process Waste Volume Reduction	Demonstrate commercial technologies for decon process waste reduction (INEEL)	01
					Demonstrate filter leach processes (INEEL)	02
					Complete Pilot-Scale Demo of Selected HEPA Filter Treatment Process (INEEL)	03
					Demonstrate Sieman's HP/CORD decon process	TBD

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
					Provide recommendations for further development and demonstration	TBD
					Deploy waste minimization technologies for INTEC decon process	02
	WT-05-01	Tank Closure	A9363	Chemical Cleaning of Tanks	Demonstrate chemical cleaning technologies on tank waste samples (SRS)	01
					Demonstrate chemical cleaning technologies using waste simulants (INEEL)	02
					Demo Chemical Cleaning System for tanks using actual waste samples (INEEL)	03
					Issue decision to proceed with deployment of Chemical Cleaning System (INEEL)	03
			A9588	Leaching and Treatment of Technetium for Tank Closure	Demonstrate identification of species and properties of Tc-99 in tank waste (Hanford, SRS)	01
					Demonstrate removal methods for Tc-99	02
			A9923	Enhanced Grout Formulations for Tank Closure	Demonstrate comparative performance of grout formulations (WV, ORNL, INEEL)	01
			A9960	Sequestering of Contaminant Migration	Demonstrate performance of reducing grout (SRS, Hanford)	02
					Demonstrate sequestering getters (Hanford)	02
			A9985	Demonstration of Grout Injection Technology for Tank Closure	Demonstrate grout injection for OBG tanks (SRS)	01
					Deploy grout injection on TH-4 (ORNL)	01
			AA1S1	Pre-Closure Interim Tank Maintenance	Recommend pre-closure configurations for tank waste storage and interim maintenance	02
			AA3S1	Chemical Cleaning	Recommend alternate chemical treatment methods for enhancing the removal of tank heels (Hanford, SRS)	01

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
					Demonstrate chemical treatment of tank heels using waste simulants	02
	WT-12-01	Closure Enhancements	AA303	Waste Retrieval from Confined Spaces	Select technology for Tank 16 annulus retrieval	01
					Demonstrate technology for Tank 16 annulus retrieval	02
			AA310	Tank Decontamination and Dismantling	Recommend technology for tank exhumation	02
Tank Waste Pretreatment Immobilization						
	WT-06-01	Enhanced Immobilization Productivity	A9768	Specify and Enhance Design of HLW Glass Melters	Demonstrate design improvements for DWPF pour spout inserts (SRS)	01
					Demonstrate improved melter technology (SRS, INEEL)	01
					Demonstrate noble metals behavior in melters (SRS, INEEL)	01
					Conduct three pilot-scale melter runs at Clemson University	01
					Demonstrate cold crucible melter technology (SRS, INEEL)	02
					Demo Pilot-Scale Melter Runs (INEEL)	03
			A9773	Improve Waste Loading in HLW Glass	Demonstrate effects of high-temperature melts (Hanford & SRS)	01
					Demonstrate glass formulation options for INEEL flowsheet (INEEL)	01
					Demonstrate effects of multi-phase glass on phase separation (Hanford, SRS)	02
					Demonstrate improved model for predicting viscosity (Hanford, SRS)	02

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
					Demonstrate glass formulation options for INEEL flowsheet (INEEL)	02
			A9777	Remote Disassembly of HLW Melters and Other Processing Equipment	Recommend methods to remove glass from failed melters (WV, SRS)	01
					Demonstrate glass removal methods (WV, SRS)	02
					Demonstrate size reduction & disposal of vitrification expended materials (WV, SRS)	02
					Deploy improved D&D equipment for disposal of vitrification expended materials (WV - Site funded)	02
					Complete Demo of Size Reduction and Disassembly of Failed Melters and Ancillary Equipment (WV, SRS)	04
			AA7S2	New Melter Technology	Complete cold crucible induction-heater melter pilot test facility (Hanford, INEEL, SRS)	02
	WT-07-01	Acceptance Criteria and Canister Storage	A9719	Conditioning and Immobilization of Low-Activity Waste	Deploy grout pilot plant for newly generated liquid waste (INEEL)	01
					Demonstrate capability to stabilize hazardous components in waste forms (ORNL, INEEL)	02
					Complete Demo of Grouting of INEEL Liquid Low-Activity Waste in the Liquid Waste Treatment-Pilot Plant (LWT-PP)	03
					Deploy Liquid Waste Treatment Demonstration Process on INEEL Low-Activity Liquid Waste (INEEL)	04

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
			A9748	Testing and Prediction of Long-Term Waste Glass Performance	Conduct testing of long-term LAW glass performance (Hanford)	01
					Demonstrate performance validation for LAW glass composition region (Hanford)	02
					Issue recommendation for product acceptance method and applicability criteria for Hanford ILAW disposal (Hanford)	03
			A9772	Alternative HLW Canister Decontamination Techniques	Recommend canister decontamination methods (WV, SRS)	01
					Demonstrate canister decontamination methods (WV, SRS)	02
					Demonstrate pilot-scale canister decontamination plant (WV, SRS)	02
			AA7S1	Durability of Multiphase Waste Glasses	Recommend viability of predictable multiphase waste glasses (Hanford, INEEL, SRS)	01
	WT-08-01	Solids Pretreatment	A9278	Slurry Transfer and Tank Waste Mixing Monitors	Deploy Dual Coriolis Slurry Monitor (SRS)	01
			A9554	Hanford Tank Waste Chemistry	Demonstrate recommended waste transfer operating envelopes (Hanford, SRS)	01
					Demonstrate saltcake dissolution properties at lab scale (Hanford)	01
					Recommend operating envelopes for pipeline waste transfer (Hanford, SRS)	02
			A9555	Sludge Washing and Dissolution	Demonstrate enhanced sludge washing on Hanford Group 1 tank samples (Hanford)	01
					Demonstrate enhanced sludge washing on Hanford Group 2 tank samples (Hanford)	02

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
			A9584	Cross-Flow Filtration	Demonstrate CUF on waste simulants (INEEL)	01
					Demonstrate CUF on tank waste samples (INEEL)	02
			AA5S1	Removal of Key Non-Radioactive Elements from Tank Waste	Demonstrate removal processes for key non-radioactive elements with simulated waste (Hanford & SRS)	01
					Demonstrate removal processes for non-radioactive elements with tank waste samples (Hanford & SRS)	02
	WT-09-01	Radionuclide Removal	A9501	INEEL Integrated Radionuclide Separations Process	Conduct pilot-scale demonstration of radionuclide separation technologies on calcine samples (INEEL)	01
					Demonstrate solvent extraction technology on Calcine samples (INEEL)	01
					Demonstrate scale-up of ion exchange technology (INEEL)	01
			A9570	Salt Disposition	Demonstrate salt processing options with simulants and tank waste samples to support process down-select	01
					Perform optimization testing on selected salt processing option to minimize technical risk	02
			A9586	CIF Evaporator	Complete SLS and CIF evaporator deployments (SRS, ORNL)	01
	WT-10-01	Immobilization Enhancements	A9749	Glass Monolith Surface Area	Demonstrate model to predict glass surface area (Hanford)	02
	WT-11-01	Constituent Separation and Analysis	A9264	Improve Waste Analytical Methods	Demonstrate accuracy and precision of LA/MS for glass and tank waste analysis (Hanford)	01

Table D.1. (contd)

Product Line	Work Package	Work Package Title	Resp ID	Response Title	Milestones	FY
					Conduct round robin demonstrations of Tc-99 analysis (Hanford)	01
					Demonstrate improved laboratory analytical procedures to reduce secondary waste (INEEL)	02
					Conduct round robin demonstrations of Tc-99 analysis (Hanford)	02
			A9514	Removal of Chloride from Waste Solutions	Demonstrate chloride removal at pilot scale (INEEL)	02
			A9518	Mercury Removal from Waste Solutions	Demonstrate mercury removal at lab scale (INEEL)	02
			A9532	Calcine Dissolution Solubility and Kinetics	Demonstrate calcine dissolution modeling (INEEL)	02
			A9566	Vitrification Recycle	Demonstrate effects of boildown on evaporator operation and corrosion (SRS)	01
					Demonstrate corrosion effects on evaporator materials (SRS)	02
			AA201	Sludge Mapping and Volume Estimates	Demonstrate feasibility of sludge mapping for waste volume estimates (SRS)	01
					Deploy sludge mapping for waste volume estimates (SRS)	02

Appendix E

Planned Performance

Appendix E

Planned Performance

Table E.1 presents TFA's planned multiyear performance estimates for FY 2001-2005. The table summarizes the number of deployments, demonstrations, and ready for implementations (RFIs).

Table E.1. Planned Performance[a]

Product Line	Work Package	Work Package Title	Response ID	Response Title	Deployments					Demonstrations					RFI's				
					FY01	FY02	FY03	FY04	FY05	FY01	FY02	FY03	FY04	FY05	FY01	FY02	FY03	FY04	FY05
Tanks Waste Retrieval & Closure	**WT-01-01**	Transfer Line/Unplugging/Feed Analysis																	
			A9246	Waste Sampling and At-Tank Analysis		1				2									
			A9376	Waste Transfer Line Plugging Prevention and Unplugging Methods						2	1	1							
	WT-02-01	Waste Mobilization and Retrieval																	
			A9331	Dry Solid Waste Retrieval		2				1	1								
			A9359	Waste Mixing and Retrieval		3				3	2				1				
			A9362	Salt Cake Dissolution Retrieval			1			1	1								
			A9365	Waste Transfer Pumping		1				1							1		
			A9382	Horizontal and Small Tank Sludge Mixing and Retrieval	2	1	1			3	2	1			1				
			AA202	In-Situ Waste Characterization	1	1				1	1								
			AA203	Residual Waste Sampling		2	1			2									
	WT-03-01	Tank Integrity and Heel Retrieval																	
			A9175	Tank Integrity Inspection Techniques	1	1	2	2		1	4	2							
			A9361	Heel Retrieval from Obstructed Tanks	1	1									1				
			A9367	Unobstructed Tank Heel Retrieval		1					1	1							
			AA3S2	SST Retrieval from Potential Leaking Tanks							1				1	1			
	WT-04-01	Ancillary Tank Equipment Enhancements																	
			A9143	HLW Tank Corrosion Control and Monitoring	4					1						2			
			A9171	Alternative Air Filtration Technology	1	1				3	2					1			
			A9352	Remote Systems for Pit Operations and Mainteneance	1		2				2								

Table E.1. (contd)

Product Line	Work Package	Work Package Title	Response ID	Response Title	Deployments					Demonstrations					RFI's				
					FY01	FY02	FY03	FY04	FY05	FY01	FY02	FY03	FY04	FY05	FY01	FY02	FY03	FY04	FY05
			A9508	Decon Process Waste Volume Reduction		1				1	1	1							
	WT-05-01	Tank Closure																	
			A9363	Chemical Cleaning of Tanks			1			1	1	1					1		
			A9588	Leaching and Treatment of Technetium for Tank Closure						1	1								
			A9923	Enhanced Grout Formulations for Tank Closure						3									
			A9924	Tank Closure Criteria/Decision Support															
			A9960	Sequestering of Contaminant Migration							3								
			A9985	Demonstration of Grout Injection Technology for Tank Closure	1					1					1				
			AA1S1	Pre-Closure Interim Tank Maintenance												1			
			AA3S1	Chemical Cleaning							1				1				
	WT-12-01	Closure Enhancements																	
			AA303	Waste Retrieval from Confined Spaces							1				1				
			AA310	Tank Decontamination and Dismantling							1					1			
	Subtotal				**12**	**16**	**8**	**2**		**28**	**27**	**7**			**7**	**6**	**2**		
Tank Waste Pretreatment & Immobilization	**WT-06-01**	Enhanced Immobilization Productivity																	
			A9768	Specifiy and Enhance Design of HLW Glass Melters						4	2	1							
			A9773	Improve Waste Loading in HLW Glass						3	5								
			A9777	Remote Disassembly of HLW Melters and Other Processing Equipment		1					4		2		2				

Table E.1. (contd)

Product Line	Work Package	Work Package Title	Response ID	Response Title	Deployments					Demonstrations					RFI's				
					FY01	FY02	FY03	FY04	FY05	FY01	FY02	FY03	FY04	FY05	FY01	FY02	FY03	FY04	FY05
			AA7S2	New Melter Technology							3								
	WT-07-01	Acceptance Criteria and Canister Storage																	
			A9719	Conditioning and Immobilization of Low-Activity Waste	1			1		1	2	1							
			A9748	Testing and Prediction of Long-Term Waste Glass Performance						1							1		
			A9772	Alternative HLW Canister Decontamination Techniques							4				1				
			AA7S1	Durability of Multiphase Waste Glasses											3				
	WT-08-01	Solids Pretreatment																	
			A9278	Slurry Transfer and Tank Waste Mixing Monitors	1														
			A9554	Hanford Tank Waste Chemistry			1			3						2			
			A9555	Sludge Washing and Dissolution						1	1								
			A9584	Cross-Flow Filtration						1	1								
			AA5S1	Removal of Key Non-Radioactive Elements from Tank Waste						2	2								
	WT-09-01	Radionuclide Removal																	
			A9501	INEEL Integrated Radionuclide Separations Process						3									
			A9570	Salt Disposition						1	1								
			A9586	CIF Evaporator	2														
	WT-10-01	Immobilization Enhancements																	
			A9749	Glass Monolith Surface Area							1								
	WT-11-01	Constituent Separation and Analysis																	
			A9264	Improve Waste Analytical Methods						2	2								
			A9514	Removal of Chloride from Waste Solutions							1								

Table E.1. (contd)

Product Line	Work Package	Work Package Title	Response ID	Response Title	Deployments					Demonstrations					RFI's				
					FY01	FY02	FY03	FY04	FY05	FY01	FY02	FY03	FY04	FY05	FY01	FY02	FY03	FY04	FY05
			A9518	Mercury Removal from Waste Solutions							1								
			A9532	Calcine Dissolution Solubility and Kinetics							1								
			A9566	Vitrification Recycle						1	1								
			AA201	Sludge Mapping and Volume Estimates		1				1									
	Subtotal				**4**	**2**	**1**	**1**		**24**	**34**	**2**	**2**		**6**	**2**	**1**		

Appendix F

TFA's Focus Area-Centered Program Components' Technical Work

Appendix F

TFA's Focus Area-Centered Program Components' Technical Work

This appendix summarizes in tabular form (Table F.1) the TFA's known or expected support to OST programs for FY01 and FY02. Program management support costs are not indicated.

Table F.1. TFA Suupport to OST Programs ($x1,000)

TFA Response #	Project Name	FY01 Funding	FY02 Funding
CROSSCUTTING PROGRAMS			
Characterization, Monitoring, and Sensor Technology (CMST) Crosscutting Program			
A9175	Tank Integrity Inspection Techniques	275	125
AA202	In-Situ Waste Characterization	0	200
A9278	Slurry Transfer and Tank Waste Mixing Monitors	0	150
TOTALS		**275**	**475**
Efficient Separations and Processing (ESP) Crosscutting Program			
A9555	Sludge Washing and Dissolution	825	800
AA3S1	Selective Chemical Dissolution of Tank Heels to Improve Retrieval	200	350
AA5S1	Removal of Key Non-Radioactive Elements from Tank Waste	250	250
A9588	Leaching and Treatment of Technetium for Tank Closure	0	350
TOTALS		**1275**	**1750**
Robotics (RBX) Crosscutting Program			
A9175	Tank Integrity Inspection Techniques	1350	2430
A9352	Remote Systems for Pit Operations and Maintenance	580	1450
A9361	Heel Retrieval from Obstructed Tanks	150	400
A9367	Unobstructed Tank Heel Retrieval	400	100
A9777	Remote Disassembly of HLW Melters	100	105
A9331	Dry Solid Waste Retrieval	0	100
TOTALS		**2580**	**4585**

Table F.1. (contd)

TFA Response #	Project Name	FY01 Funding	FY02 Funding
	OTHER PROGRAMS		
Accelerated Site Technology Deployment (ASTD) Program			
A9367	GAAT Closeout	70	0
A9586	CIF Evaporator	200	0
TOTALS		**270**	**0**
Industry Programs			
A9246	Waste Sampling and At-Tank Analysis	0	1100
TOTALS		**0**	**1100**
International Programs			
A9246	Waste Sampling and At-Tank Analysis (AEA)	350	140
A9363	Chemical Cleaning of Tanks (Russia)	100	100
A9501	INEEL Integrated Radionuclide Separations Process (Russia)	150	150
A9554	Hanford Tank Waste Chemistry (AEA)	125	125
A9719	Conditioning and Immobilization of Low-Activity Waste (AEA)	275	100
AA203	Residual Waste Sampling (AEA)	400	300
AA7S2	New Melter Technology (Russia)	100	0
N/A	Immobilization Support to Argentina (Argentina)	300	TBD
TOTALS		**1800**	**915**
TFA Support to University Programs			
A9278	Slurry Transfer and Tank Waste Mixing Monitors (FIU)	500	0
A9376	Waste Transfer Lines Plugging Prevention and Unplugging Methods (FIU)	1050	900
A9544	Hanford Tank Waste Chemistry (MSU & FIU)	850	550
A9555	Sludge Washing and Dissolution (MSU DIAL)	200	200
A9768	Specify and Enhance Design of HLW Glass Melters (FIU)	175	120
N/A	University Strategic Tasks (MSU & FIU)	1125	1240
N/A	Robotics University (Various)	1200	0
TOTALS		**5100**	**3010**
Basic and Applied Research			
N/A	Applied Research – CMST	257	TBD
N/A	Applied Research – ESP	812	TBD
N/A	Basic Science (via EMSP)	5700	7100
TOTALS		**6769**	**7100**
Grand Totals of All Programs		**18069**	**18935**

Environmental Management Science Program

Under DOE's Environmental Management Science Program (EMSP) basic research addressing fundamental issues that may be critical to achieving EM's mission and goals is conducted. In the first three years of the program (1996, 1997, 1998), the EMSP awarded a total of 68 projects addressing HLW as the primary problem area. An additional 54 projects address other problem areas, but may be applicable to TFA requirements. The TFA is monitoring the progress of those projects that are specifically applicable to radioactive tank waste site science and technology needs, including

- technetium chemistry
- chemical and physical property measurement
- radionuclide separations
- waste chemistry and physical properties
- improving HLW glass waste forms
- validating waste form performance
- characterizing moisture and contaminant concentrations and transport in the vadose zone beneath tanks and disposal facilities.

The 1999 EMSP awards address subsurface contamination in the vadose zone and health risk from low-dose radiation and are of particular interest to the Subsurface Contamination Focus Area and the Low Dose Radiation Research Program. The TFA monitors the progress of these most recent awards for potential application to tank closure and waste disposal technology needs.

Table F.2 lists the projects by applicable site science need or related TFA multi-year technical response. The projects marked by at double asterisk (**) indicate the higher priority science projects based on 1) a Technical Team review of the most recent project summaries posted on the EMSP webpage (typically from spring 1999) and 2) a more detailed review of 20 of the projects presented at the EMSP National Workshop held in Atlanta, Georgia in April 2000. Several projects were judged of limited value in addressing current needs.

All science needs submitted by the sites in FY99 and FY00 are included in Table F.2. In FY00, Hanford did not resubmit some of their FY99 science needs. Because several EMSP projects are responsive to those needs, we have included all Hanford science needs from FY99 and FY00 in our assessment. In this table, the EMSP projects may be listed as addressing more than one science need. Those projects judged to be of limited value in addressing current science needs are listed at the end.

Applied Research

The TFA Applied Research (AR) program is directed toward science and technology at earlier stages in the development process. It's objectives are to determine feasibility of technologies that address the objectives of the site user needs or to obtain scientific information that is more specific than that addressed in the EMSP. Through the AR program, alternatives to the baseline site technologies may be investigated to determine whether tank clean up objectives can be achieved faster, more reliably, or at significantly reduced cost.

One priority objective of the program is to transition the most promising and relevant EMSP projects to more completely impact the sites by targeting the fundamental science to site applications. Technology concepts may be advanced through the early development stages (e.g. Stages 2-4). Technologies that successfully pass the gates for further development may then be incorporated into TFA projects.

The FY01 program provides $1.069 million for an open research call to be administered by NETL with topic areas provided by the TFA.

Table F.2. Science Needs and Related EMSP Projects

Need #, MYTR #, or EMSP Project #		Site Need, MYTR Title, and EMSP Project Title	Budget	Award Year	Principle Investigator	Organization
RL-WT031-S – Rapid Waste Characterization						
54674		Design and Development of a New Hybrid Spectroelectrochemical Sensor	$850,000	1996	Dr. William R. Heineman	University of Cincinnati
55318	**	Improved Analytical Characterization of Solid Waste-Forms by Fundamental Development of Laser Ablation Technology	$1,229,167	1996	Dr. Richard E. Russo	LBNL
60075	**	Particle Generation by Laser Ablation in Support of Chemical Analysis of High Level Mixed Waste from Plutonium Production Operations	$544,500	1997	Dr. J Thomas Dickinson	Washington State University
60217		Optically-Based Array Sensors for Selective In Situ Analysis of Tank Waste	$600,000	1997	Dr. Gilbert M. Brown	ORNL
RL-WT032-S – Monitoring of Key Waste Physical Properties During Retrieval and Transport						
54890	**	On-Line Slurry Viscosity and Concentration Measurement as a Real-time Waste Stream Characterization Tool	$691,154	1996	Dr. Robert L. Powell	Univ. of California at Davis
55179		Acoustic Probe for Solid-Gas-Liquid Suspensions	$750,841	1996	Dr. Lawrence L. Tavlarides	Syracuse University
RL-WT033-S – Chemistry of Problem Constituents for HLW Vitrification						
65422		Modeling of Spinel Settling in Waste Glass Melter	$875,000	1998	Dr. Pavel R. Hrma	PNNL
RL-WT034-S – Long-Term Performance of LAW Forms						
54982		Analysis of Surface Leaching Processes in Vitrified High-Level Nuclear Wastes Using In-Situ Raman Imaging and Atomistic Modeling	$559,000	1996	Dr. Joseph H. Simmons	University of Florida
55042		Quantifying Silica Reactivity in Subsurface Environments: Controls of Reaction Affinity and Solute Matrix on Quartz and SiO2 Glass Dissolution Kinetics	$358,994	1996	Dr. Patricia M. Dove	Georgia Institute of Tech.
60362	**	Ion-Exchange Processes and Mechanisms in Glasses	$901,000	1997	Dr. B. Peter McGrail	PNNL
RL-WT035-S – Moisture Flow and Contaminant Transport in Air Conditions						
RL-WT036-S – Alternative Waste Form Development						

Table F.2. (contd)

Need #, MYTR #, or EMSP Project #		Site Need, MYTR Title, and EMSP Project Title	Budget	Award Year	Principle Investigator	Organization
60345	**	New Silicotitanate Waste Forms: Development and Characterization	$1,200,000	1997	Dr. Mari Lou Balmer	PNNL
65366		Physical, Chemical and Structural Evolution of Zeolite-Containing Waste Forms Produced from Metakaolinite and Calcined HLW	$510,000	1998	Dr. Michael Grutzeck	Penn State University
RL-WT037-S – Sludge Treatment						
54765		Enhanced Sludge Processing of HLW: Hydrothermal Oxidation of Chromium, Technetium, and Complexants by Nitrate	$1,020,000	1996	Dr. Steven J. Buelow	LANL
54773		Microstructural Properties of High Level Waste Concentrates and Gels with Raman And Infrared Spectroscopies	$465,000	1996	Dr. Stephen F. Agnew	LANL
60403		Phase Chemistry of Tank Sludge Residual Components	$1,157,000	1997	Dr. James L Krumhansl	SNL
65368	**	Speciation, Dissolution, and Redox Reactions of Chromium Relevant to Pretreatment and Separation of High-Level Wastes	$899,375	1998	Dr. Dhanpat Rai	PNNL
65411	**	Precipitation and Deposition of Aluminum-Containing Phases in Tank Wastes	$1,120,000	1998	Dr. Jun Liu	PNNL
	**	Indicates a higher priority science project based on TFA Technical Team review				
RL-WT038-S – Process Models for Sludge Treatment						
59982		Reactivity of Peroxynitritie: Implications for Hanford Waste Management and Remediation	$700,000	1997	Dr. Sergei Lymar	BNL
RL-WT039-S – Advanced Methods for Achieving LLW Volume Minimization						
65339	**	Ion Recognition Approach to Volume Reduction of Alkaline Tank Waste by Separation and Recycle of Sodium Hydroxide and Sodium Nitrate	$900,000	1998	Dr. Bruce A Moyer	ORNL
RL-WT040-S – Mechanisms of Line Plugging						
RL-WT041-S – Radionuclide Partitioning						

Table F.2. (contd)

Need #, MYTR #, or EMSP Project #		Site Need, MYTR Title, and EMSP Project Title	Budget	Award Year	Principle Investigator	Organization
54621	**	Chemical Speciation of Strontium, Americium, and Curium in High-Level Waste: Predictive Modeling of Phase Partitioning During Tank Processing	$1,050,778	1996	Dr. Andrew R. Felmy	PNNL
59993		Dynamic Effects of Tank Waste Aging on Radionuclide-Complexant Interactions	$550,000	1997	Dr. Rebecca Chamberlin	LANL
65318		Actinide-Aluminate Speciation in Alkaline Radioactive Waste	$1,334,000	1998	Dr. David L. Clark	LANL
65352		Developing a Fundamental Basis for the Characterization, Separation, and Disposal of Plutonium and Other Actinides in High Level Radioactive Waste: The Effect of Temperature and Electrolyte Concentrations on Actinide Speciation	$865,271	1998	Dr. Sue B. Clark	Washington State University
65398		Characterization of Actinides in Simulated Alkaline Tank Waste Sludges and Leach Solutions	$930,000	1998	Dr. Kenneth L. Nash	ANL
RL-WT042-S – Flammable Gas Generation, Retention, and Release in HLW Tanks						
54646		Interfacial Radiolysis Effects in Tank Waste Speciation	$871,389	1996	Dr. Thomas M. Orlando	PNNL
54656		Mixing Processes in High-Level Waste Tanks	$416,830	1996	Dr. Per F. Peterson	Univ. of California, Berkeley
60451		Mechanics of Bubbles in Sludges and Slurries (2 listed w/different lead investigators both figures included in total of budget summary)	$1,132,000	1997	Dr. Phillip A Gauglitz	PNNL
65408		Mechanisms and Kinetics of Organic Aging in High-Level Nuclear Wastes	$900,000	1998	Dr. Donald M. Camaioni	PNNL
RL-WT043-S – Effect of Human and Natural Influences on Long-Term Water Distribution						
RL-WT044-S – Distribution of Recharge Rates						
RL-WT045-S – Vadose Zone Flow Simulation Tool Under Arid Conditions						
65410		Rapid Migration of Radionuclides Leaked from High-Level Waste Tanks: A Study of Salinity Gradients, Wetted Path Geometry and Water Vapor Transport	$905,000	1998	Dr. Anderson L. Ward	PNNL
RL-WT046-S – Getter Materials						

Table F.2. (contd)

Need #, MYTR #, or EMSP Project #		Site Need, MYTR Title, and EMSP Project Title	Budget	Award Year	Principle Investigator	Organization
65370		Actinide-Specific Interfacial Chemistry of Monolayer Coated Mesoporous Ceramics	$1,200,000	1998	Dr. Glen E. Fryxell	PNNL
RL-WT047-S – Tritium Separations						
	**	Indicates a higher priority science project based on TFA Technical Team review				
RL-WT048-S – Innovative Methods of Radionuclide Separation						
54735		Development of Inorganic Ion Exchangers for Nuclear Waste Remediation	$599,999	1996	Dr. Abraham Clearfield	Texas A&M University
55087	**	Design and Synthesis of the Next Generation of Crown Ethers for Waste Separations: An Inter-Laboratory Comprehensive Proposal	$1,920,000	1996	Dr. Bruce A. Moyer	ORNL
60123		Potential-Modulated Intercalation of Alkali Cations into Metal Hexacyanoferrate Coated Electrodes	$300,000	1997	Dr. Daniel T. Schwartz	University of Washington
RL-WT049-S – Effect of Processing on Waste Rheological and Sedimentation Properties						
54628	**	Colloidal Agglomerates in Tank Sludge: Impact on Waste Processing	$1,788,000	1996	Dr. Joel M. Tingey	PNNL
RL-WT050-S – Effect of Organic Constituents on Waste Processing						
55229		The Nox System in Nuclear Waste	$1,200,833	1996	Dr. Dan Meisel	ANL
RL-WT051-S – Foam Generation and Stability						
60143	**	Foaming in Radioactive Waste Treatment and Immobilization Processes	$360,360	1997	Dr. Darsh T. Wasan	Illinois Institute of Technology
RL-WT052-S – Characterization of Organic Species in Waste Feed to LAW and HLW Treatment Facilities						
59978		Thermospray Mass Spectrometry Ionization Processes Fundamental Mechanisms for Speciation, Separation and Characterization of Organic Complexants in DOE Wastes	$590,000	1997	Dr. John Caton	ORNL
65340		Detection and Characterization of Chemicals Present in Tank Waste	$1,004,992	1998	Dr. Panos G. Datskos	ORNL
65425		Mass Spectrometric Fingerprinting of Tank Waste Using Tunable, Ultrafast Infrared Lasers	$760,000	1998	Dr. Richard F. Haglund, Jr.	Vanderbilt University

Table F.2. (contd)

Need #, MYTR #, or EMSP Project #		Site Need, MYTR Title, and EMSP Project Title	Budget	Award Year	Principle Investigator	Organization
RL-WT053-S – Contaminant Mobility Beneath Tank Farms						
RL-WT054-S – Solids Yield and Deagglomeration						
RL-WT055-S – Tank Integrity Verification						
RL-WT056-S – Half-Lives of Se-79 and Sn-126						
RL-WT057-S – Materials for Long-Term Waste Isolation						
54691		Radiation Effects on Materials in the Near-Field of Nuclear Waste Repository	$408,000	1996	Dr. Lu-Min Wang	University of Michigan
RL-WT075-S – HLW Solids Phase Characterization						
RL-WT076-S – Plutonium Interaction with Silicates						
RL-WT077-S – Improvements to Salt Well Pumping						
RL-WT078-S – Plutonium Segregation and Association in HLW						
	**	Indicates a higher priority science project based on TFA Technical Team review				
RL-WT079-S – Double Shell Tank Corrosion Chemistry						
60219	**	Development of Advanced Electrochemical Emission Spectroscopy for Monitoring Corrosion in simulated DOE Liquid Waste	$350,000	1997	Dr. Digby D. Macdonald	Penn State University
60401		Mechanism of Pitting Corrosion Prevention by Nitrite in Carbon Steel Exposed to Dilute Salt Solutions	$650,000	1997	Dr. Philip E. Zapp	SRTC
SR00-2049-S – Technetium Chemistry Under Waste Removal Conditions						
59990	**	Fundamental Chemistry, Characterization, and Separation of Technetium Complexes in Hanford Waste	$730,000	1997	Dr. Norman C. Schroeder	LANL
60296		Research Program to Investigate the Fundamental Chemistry of Technetium	$900,000	1997	Dr. Norman M. Edelstein	LBNL
SR00-2050-S – Fracture Toughness Properties for Carbon Steel Utilized for Nuclear Waste Containment Vessels						
SR00-2053-S – Develop an Alternative Sorbent to Replace Monosodium Titanate for Sr and Actinide Removal						
54735		Development of Inorganic Ion Exchangers for Nuclear Waste Remediation	$599,999	1996	Dr. Abraham Clearfield	Texas A&M University

Table F.2. (contd)

Need #, MYTR #, or EMSP Project #		Site Need, MYTR Title, and EMSP Project Title	Budget	Award Year	Principle Investigator	Organization
60345	**	New Silicotitanate Waste Forms: Development and Characterization	$1,200,000	1996	Dr. Mari Lou Balmer	PNNL
SR00-2054-S – Develop Improved Radiochemical Analysis for High Ionic Strength Samples						
65339	**	Ion Recognition Approach to Volume Reduction of Alkaline Tank Waste by Separation and Recycle of Sodium Hydroxide and Sodium Nitrate	$900,000	1998	Dr. Bruce A Moyer	ORNL
ID-S.1.02 – Continuous Emissions Monitors for Offgas Analysis						
65421		Correlation of Chemisorption and Electronic Effects for Metal/Oxide Interfaces: Transducing Principles for Temperature-Programmed Gas Microsensors	$1,070,000	1998	Dr. Steve Semancik	NIST
AA201 – Sludge Mapping and Volume Estimates						
55141		Imaging and Characterization of Waste Materials Inside an Underground Storage Tank Using Seismic Normal Modes	$575,703	1996	Dr. M. Nafi Toksoz	Massachusetts Institute of Technology
A9359 – Waste Mixing and Retrieval						
65371		Numerical Modeling of Mixing of Chemically Reacting, Non-Newtonian Slurry for Tank Waste Retrieval	$657,986	1998	Dr. David A. Yuen	University of Minnesota
A9570 – Salt Cesium Separation Processes						
55087	**	Design and Synthesis of the Next Generation of Crown Ethers for Waste Separations: An Inter-Laboratory Comprehensive Proposal	$1,920,000	1996	Dr. Bruce A. Moyer	ORNL
60345	**	New Silicotitanate Waste Forms: Development and Characterization	$1,200,000	1996	Dr. Mari Lou Balmer	PNNL
A9588 – Leaching and Treatment of Technetium for Tank Closure						
60017	**	Removal of Technetium, Carbon Tetrachloride, and Metals from DOE Properties	$390,000	1997	Dr. Thomas E. Mallouk	Penn State University
	**	Indicates a higher priority science project based on TFA Technical Team review				
A9768 – Specify and Enhance Design and Operations of HLW Melters						

Table F.2. (contd)

Need #, MYTR #, or EMSP Project #		Site Need, MYTR Title, and EMSP Project Title	Budget	Award Year	Principle Investigator	Organization
65435	**	Millimeter-Wave Measurements of High Level and Low Activity Glass Melts	$1,429,417	1998	Dr. Paul P. Woskov	Massachusetts Institute of Technology
A9773 – Improve Waste Loading in HLW Glass						
59827		The Influence of Radiation and Multivalent Cation Additions on Phase Separation and Crystallization of Glass	$723,000	1997	Dr. Michael C. Weinberg	University of Arizona
60020		Stability of High-Level Waste Forms	$762,000	1997	Dr. Theodore M. Besmann	ORNL
Projects Evaluated and Judged to be of Limited Value for Current Needs						
55188		Chemical Decomposition of High-Level Nuclear Waste Storage/Disposal Glasses Under Irradiation	$489,000	1996	Dr. David L. Griscom	Naval Research Laboratory
54595		f-Element Ion Chelation in Highly Basic Media	$499,998	1996	Dr. Robert T. Paine	University of New Mexico
55367		Investigation of Microscopic Radiation Damage in Waste forms Using ODNMR and AEM Techniques	$698,000	1996	Dr. Guokui Liu	ANL
55137		Investigation of Novel Electrode Materials for Electrochemically-Based Remediation of High-and Low-Level Mixed Wastes in the DOE Complex	$650,000	1996	Dr. Nathan S. Lewis	California Institute of Technology
54996		Ionizing Radiation Induced Catalysis on Metal Oxide Particles	$1,110,000	1996	Dr. Michael A. Henderson	PNNL
54716		Polyoxometalates for Radioactive Waste Treatment	$333,000	1996	Dr. Michael T. Pope	Georgetown University
54672		Radiation Effects in Nuclear Waste Materials	$2,880,000	1996	Dr. William J. Weber	PNNL
54807		Studies Related to Chemical Mechanisms of Gas Formation in Hanford High-Level Nuclear Wastes	$320,000	1996	Dr. E. Kent Barefield	Georgia Institute of Technology
55294		Superconducting Open-Gradient Magnetic Separation for the Pretreatment of Radioactive or Mixed Waste Vitrification Feeds	$1,500,000	1996	Dr. Richard D. Doctor	ANL
60424		High Temperature Condensed Phase Mass Spectrometric Analysis	$680,000	1997	Dr. James E. Delmore	INEEL

Table F.2. (contd)

Need #, MYTR #, or EMSP Project #		Site Need, MYTR Title, and EMSP Project Title	Budget	Award Year	Principle Investigator	Organization
60313		Radiation Effects on Transport and Bubble Formation in Silicate Glasses	$750,000	1997	Dr. Alexander D. Trifunac	ANL
59977		Synthesis and Characterization of Templated Ion Exchange Resins for the Selective Complexation of Actinide Ions	$302,047	1997	Dr. George M. Murray	John Hopkins University Applied Physics Lab
65328		Electrically Driven Technologies for Radioactive Aerosol Abatement	$830,000	1998	Dr. David W. Depaoli	ORNL
65409		Electroactive Materials for Anion Separation - Technetium from Nitrate	$1,567,000	1998	Dr. Johanes H. Sukamto	PNNL
65351		Solution Effects on Cesium Complexation with Calixarene - Crown Ethers from Liquid to Supercritical Fluids	$296,000	1998	Dr. Chien M. Wai	University of Idaho
**	Indicates a higher priority science project based on TFA Technical Team review					

Appendix G

Description of DOE's System for Remediating Tank Waste

Appendix G

Description of DOE's System for Remediating Tank Waste

The U.S. Department of Energy (DOE) stores radioactive waste in tanks at five sites:

- Hanford Site, Washington
- Idaho National Engineering and Environmental Laboratory (INEEL), Idaho
- Oak Ridge Reservation (ORR), Tennessee
- Savannah River Site (SRS), South Carolina
- West Valley Demonstration Project (WVDP), New York.

The Tanks Focus Area (TFA) develops 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 an assessment of the needs submitted by the five sites, and qualitative judgments of the relative costs and risks of the associated tank remediation activities. This appendix provides a brief summary of the sites, the waste and waste storage environments at each site, regulatory drivers, and major tank waste remediation milestones for these five DOE sites.

G.1 Hanford Site

The Hanford Site is a 560-mi^2 former plutonium production site in the southeastern part of Washington State. It lies just north of where the Snake and Yakima rivers meet the Columbia River, and about 25 mi north of the Oregon border. This area is dry, flat land surrounded by hills. In January 1943, Hanford was selected for the nation's first industrial-scale plutonium production site. In the summer of 2000, the Federal Government designated about 300 to 560 square miles of the Hanford Site as the Hanford Reach National Monument. This environmental reserve consisting of the former Arid Lands Ecology Reserve and portions of land along the Columbia River are managed by the U.S. Fish and Wildlife Service.

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 diversified to include technology development, waste management, and environmental restoration. Hanford 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 1995b). Hanford's tank farms are located in the 200 East and 200 West Areas (see Figure G.1). In addition to cleaning up tanks, site 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 (Gephart and Lundgren 1998).

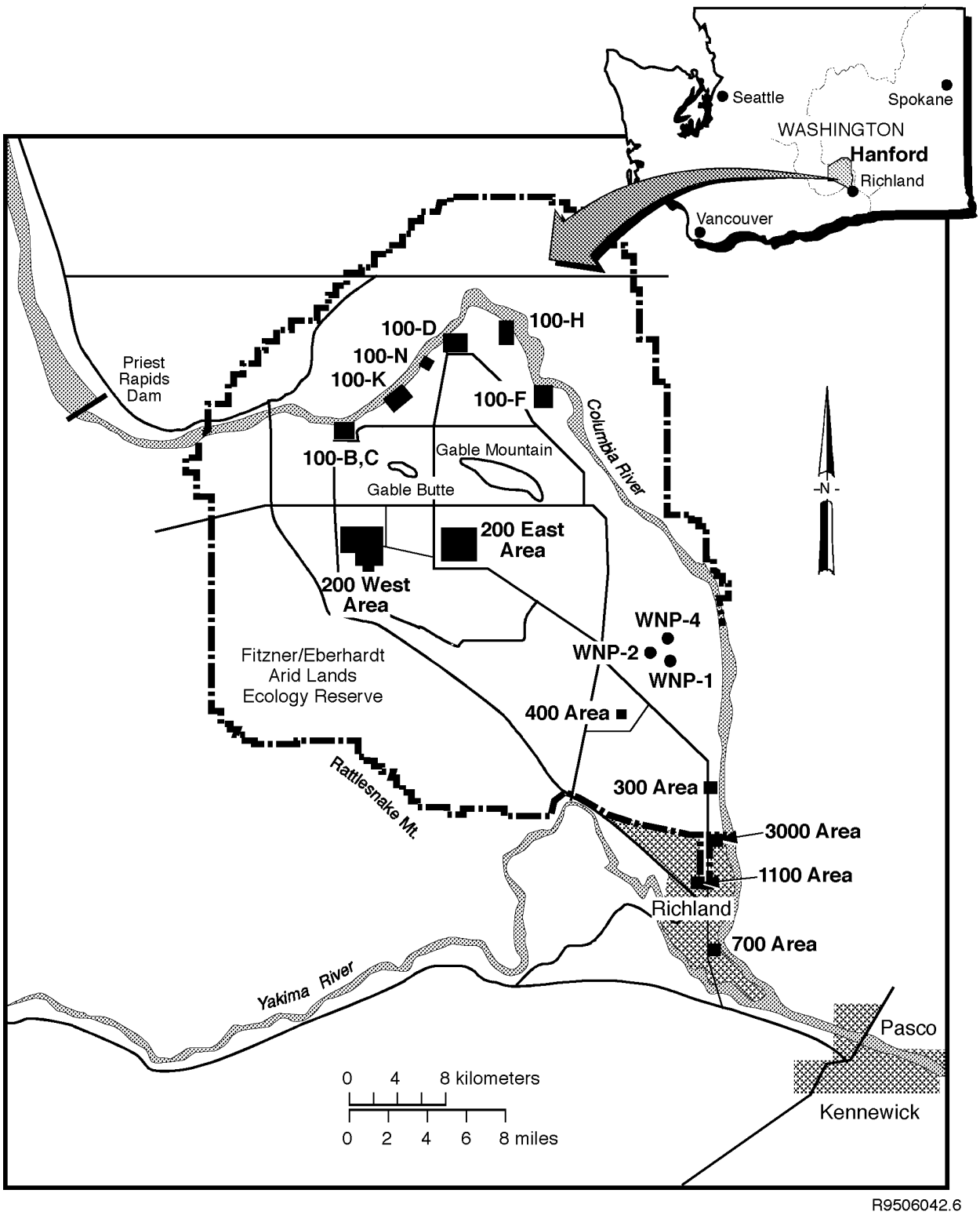

Figure G.1. Hanford Site and Major Facilities

G.1.1 Characteristics of Hanford Tank Waste

The tank waste consists of high-level waste (HLW), 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). Cesium-137 is soluble and in the supernate, and strontium-90 is largely contained in the sludge. The chemical constituents of the sludge are mostly precipitated sodium salts, heavy metals, and iron, aluminum, and other hydrated metal oxides. Saltcake is primarily sodium nitrate; and the supernate contains large amounts of dissolved sodium salts, especially nitrates and nitrites.

G.1.2 Waste Generation at the Hanford Site

The chemical and physical processes for separating plutonium from uranium and the rest of the chemical waste generated in Hanford plants changed over the years. Therefore, the composition of the waste piped to the tanks also varied.

First, uranium fuel in the form of uranium metal was surrounded by a thin-walled metal covering (called cladding) of aluminum and later Zircaloy (mostly zirconium). This was placed in one of the nine nuclear reactors built between 1943 and 1963 on the northern edge of the Site along the Columbia River. The cladding prevented chemical reactions between the uranium and cooling water, while also preventing radioactive fission products from getting into the reactor's cooling water.

The uranium fuel (uranium-238) was irradiated by being exposed to and capturing low-energy neutrons emitted by uranium-235, as it underwent fission. Irradiating uranium-238 created more complex elements, such as plutonium-239. The fission of uranium-235 also created short-lived (less than a second) to long-lived (decades to millions of years) radioactive elements called fission products. The irradiated fuel was then transported in specially shielded rail cars to a reprocessing facility in the center of the Hanford Site, away from the Columbia River.

From the 1940s to the mid-1950s, five of these reprocessing facilities were built: T Plant, B Plant, U Plant, the Reduction and Oxidation (REDOX) Plant, and the Plutonium and Uranium Extraction (PUREX) Plant. From 1944 to 1989, Hanford facilities reprocessed 110,000 ton of uranium fuel – 74% of this reprocessing took place at the PUREX Plant.

On average, approximately 1.5 lb of plutonium-239 was chemically separated from each ton of reprocessed uranium fuel. Over the years, several separation processes were used. Plutonium was recovered and purified from the dissolved uranium and fission products in the early Hanford plants by a bismuth phosphate chemical precipitation process, and in later plants by two solvent extraction processes.

The first solvent extraction process used methyl isobutyl ketone (also known as hexone) as the organic solvent with aluminum nitrate added to improve uranium and plutonium separation from other radionuclides. This process was called the REDOX process. The first large-scale operation of the REDOX process began at Hanford in 1952 in the S Plant (also called the REDOX Plant). It offered several advantages over the bismuth phosphate process by 1) reducing waste volume, 2) recovering both uranium and plutonium, and 3) allowing continuous plant operations.

An improved solvent-extraction process called the PUREX process was subsequently developed. It differed from REDOX in the use of tributyl phosphate as the organic solvent and nitric acid as a salting agent. The PUREX process was first used at the site near Savannah River Site in 1954. In 1956, the process was used at Hanford in the A Plant (also called the PUREX Plant). It offered several advantages compared to the REDOX process including 1) increased reduction in waste volume, 2) greater flexibility in process control, 3) less fire hazard, and 4) decreased operation costs.

The solvent extraction processes created two liquid waste streams. The extractant stream contained plutonium and uranium. This stream went through several chemical processing steps to separate the plutonium and uranium from each other, from other chemicals, and from other fission products. The second stream was called raffinate. This was considered waste and discharged to the tanks. It contained about 99% of all the fission products, such as cesium and strontium. Some waste was also generated from the chemical separation processes of the extractant stream. Waste considered HLW was piped to the underground tanks. Less radioactive waste was discharged to the soil through cribs and trenches.

These processes generated liquid wastes containing large quantities of contaminated nitric acid, chemicals, fission products, and miscellaneous waste. Before being piped to an underground storage tank, these highly radioactive wastes were mixed with sodium hydroxide to neutralize the acidic liquids (pH 1-4), making the solutions strongly basic (pH 10-14).

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 54 Mgal (204 M liters) of wastes, in a variety of forms. Some waste 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.

G.1.3 Storage Tanks at the Hanford Site

Hanford's tanks are cylindrical reinforced concrete structures with inner carbon-steel liners. The tanks are split into two groups based on their design: 149 tanks have a single carbon-steel liner and 28 tanks have two steel liners separated by a space called the annulus. The domes of the single-shell tanks are made of concrete without a steel inner liner. The double-shell tanks are completely enclosed by steel and reinforced by a concrete shell. Both single-shell tanks and double-shell tanks are covered with about 10 ft of soil and gravel.

These tanks contain about 200 MCi of radioactivity (mostly cesium-137 and strontium-90) and 240,000 ton of chemicals (mostly sodium nitrate). This is 50% of the radioactivity and 60% of the chemical waste at the Hanford Site.

In the 200 East and 200 West Areas, the tanks were built in 18 groups called tank farms. The farms contain from 2 to 16 tanks and hold different amounts of waste. The farms contain underground pipes so the waste can be pumped between tanks, between tank farms, from different facilities, and between the 200 East and 200 West Areas. The farms also include equipment that is used to route the waste, such as diversion boxes and valve pits.

Because of the large volume of HLW produced, tank space was very limited. Various treatments were used to reduce the amount of liquid. The first tank waste concentrators went into operation in 1951. They were steam-heated pot-like evaporators operated at atmospheric pressure outside the tanks. Waste was piped from the single-shell tanks into these concentrators to partially boil down the liquids.

Operation of the 242-S (located in 200 West Area near the REDOX Plant) and 242-A Evaporator-Crystallizers (located in 200 East Area near PUREX Plant) began in 1973 and 1977, respectively. These evaporators were used to boil off water from the tank liquids at a much larger scale than previous techniques. This was accomplished by pumping liquids from the tanks into the evaporator. Evaporation was carried out until a thick slurry was created containing about 30% by weight of solids. The slightly hot, concentrated slurry was then piped back into a tank where it cooled, crystallized, and/or settled to the tank's bottom. Between 1950 and 1995, approximately 200 Mgal (757 M liters) of liquids were evaporated from Hanford's tank waste.

Another early Hanford technique involved heating the tank's liquids from inside the tank. One approach used an electric heater inserted directly into the waste. The heated waste was then circulated into other tanks. A second approach involved circulating hot air in an individual tank through a perforated pipe.

Precipitating and settling otherwise soluble radioactive chemicals was another method; this made the tank's upper liquid layer less radioactive and less hazardous so it could be disposed of in the ground. From 1954 to 1957, radioactive cesium-137 was precipitated out of the solution by adding potassium ferrocyanide and nickel sulfate to waste piped to the Uranium Recovery Plant. After the cesium settled out, the less radioactive liquid was sent to cribs (a crib is like a shallow buried tile field used to dispose of liquid wastes). With the tank liquids lowered, more reprocessing waste could be put in the tanks. Approximately 150 tons of ferrocyanide were added to some tanks in this process.

G.1.3.1 Single-Shell Tanks

The single-shell tanks were built from 1943 to 1964 to hold the liquid radioactive waste created by the production and separation of plutonium. The 149 single-shell tanks were built in four sizes:

- 16 have a capacity of 55,000 gal (208,000 liters)
- 60 have a capacity of 530,000 gal (2 M liters)
- 48 have a capacity of 758,000 gal (2.8 M liters)
- 25 have a capacity of 1 Mgal. (3.7 M liters)

Over the years, the design of the single-shell tanks changed to better accommodate the waste being stored and to reduce the occurrence of metal corrosion and cracking. Alterations included adding equipment to handle self-boiling waste, increasing size, and changing the bottom to a flat surface instead of a bowl shape.

Another change was the addition of a grid of drain slots beneath the steel liner. The grids were designed to collect leakage and divert it to a leak detection well. Further, several 530,000-gal (2 M liters) and 758,000-gal (2.8 M liters) single-shell tanks were built in cascades of three or four tanks. These cascading tanks were connected with piping at different levels. Thus, when one tank filled to the level of

the pipe, waste would flow through the pipe to the next tank. This allowed the solid contents of the tank waste to settle to the bottom. The liquid waste that went to the next tank had less solids and less radioactivity (mostly in the form of cesium; strontium settled out in the solids).

G.1.3.2 Double-Shell Tanks

Double-shell tanks were built to provide more tank space. Liquid from the single-shell tanks was pumped into the newer, safer double-shell tanks. This left the single-shell tanks containing mostly saltcake and sludge, with some liquids. From then on, the double-shell tanks received supernatant liquids pumped directly from operating reprocessing plants such as the PUREX Plant and supernatant liquids pumped from single-shell tanks. The double-shell tanks were built from 1968 to 1986 (Figure G.2) in two sizes:

- 4 tanks have a capacity of 1.0 Mgal (3.7 M liters)
- 24 tanks have a capacity of 1.16 Mgal. (4.3 M liters)

Generally, these tanks contain liquids and thicker slurries. Some tanks also contain a bottom layer of sludge. Approximately 75% of the double-shell tank waste consists of waste pumped from single-shell tanks to minimize the potential for leakage from those tanks.

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Figure G.2. Hanford Double-Shell Tanks Under Construction

G.1.4 Regulatory Drivers for the Hanford Site

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).
- **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 1996c). 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.
- **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 tank waste remediation at Hanford. The environmental consequences of a number of alternatives for treating tank waste, including in situ treatment, are evaluated. A record of decision (ROD) for the TWRS EIS, signed in February 1997, stated that the phased approach was the best path forward for treating tank wastes.
- **Hanford Comprehensive Land-Use Plan Environmental Impact Statement** (DOE-RL 1996). DOE has developed a land use plan for Hanford that is included in the EIS for Hanford remedial actions. The Draft EIS was released in 1996, and the Final issued in 1999. The plan and the ROD 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.
- **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 tank waste end-state.
- **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 were to be completed by July 1995 and in other tanks by July 1996. These deadlines have not been met.
- **Integrated Vadose Zone Program**. This program was established to assess risk during waste retrieval, treatment, and closure from leaking tanks.
- **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.

G.1.5 Milestones for the Hanford Site

Selected Hanford Site milestones are shown in Table G.1.

Table G.1. Hanford Site Milestones

Milestone Title	Completion Date
Complete Phase I Processing (10% of waste by mass)	2018
Retrieve all SSTs	2018
Close SSTs	2024
Immobilize remaining tank waste	2028
Close all tanks	2032

G.2 Idaho National Engineering and Environmental Laboratory

The 890-mi^2 INEEL is located in eastern Idaho on a generally flat plain (see Figure G.3). The site was founded in 1949 as the National Reactor Testing Station. The first facilities, built in the early 1950s, supported the Experimental Breeder Reactor where the first usable amounts of nuclear-generated electricity were produced. Over time, a variety of other reactors were built here. A prototype for the reactor used in the first nuclear-powered submarine was developed. Also, three of the nation's commercial power reactor designs (the pressurized water reactor, the boiling water reactor, and the liquid metal cooled breeder reactor) were built and demonstrated. In total, 52 separate reactors have been built and operated at the site. All but one of these reactors has been decommissioned.

G.2.1 Characteristics of INEEL Tank Waste

As of August 1998, the total tank waste inventory stood at about 1.4 Mgal (5.3 M liters) consisting of sodium-bearing waste generated from activities incidental to reprocessing, such as facility decontamination. In general, the tank waste at the Idaho Nuclear Technology and Engineering Center (INTEC, formerly the Idaho Chemical Processing Plant) is rather different from the waste at the other DOE tank sites. The INTEC waste is characterized by large concentrations of nitrates and dissolved metals such as aluminum, potassium, and sodium with small concentrations of sulfates, chlorides,

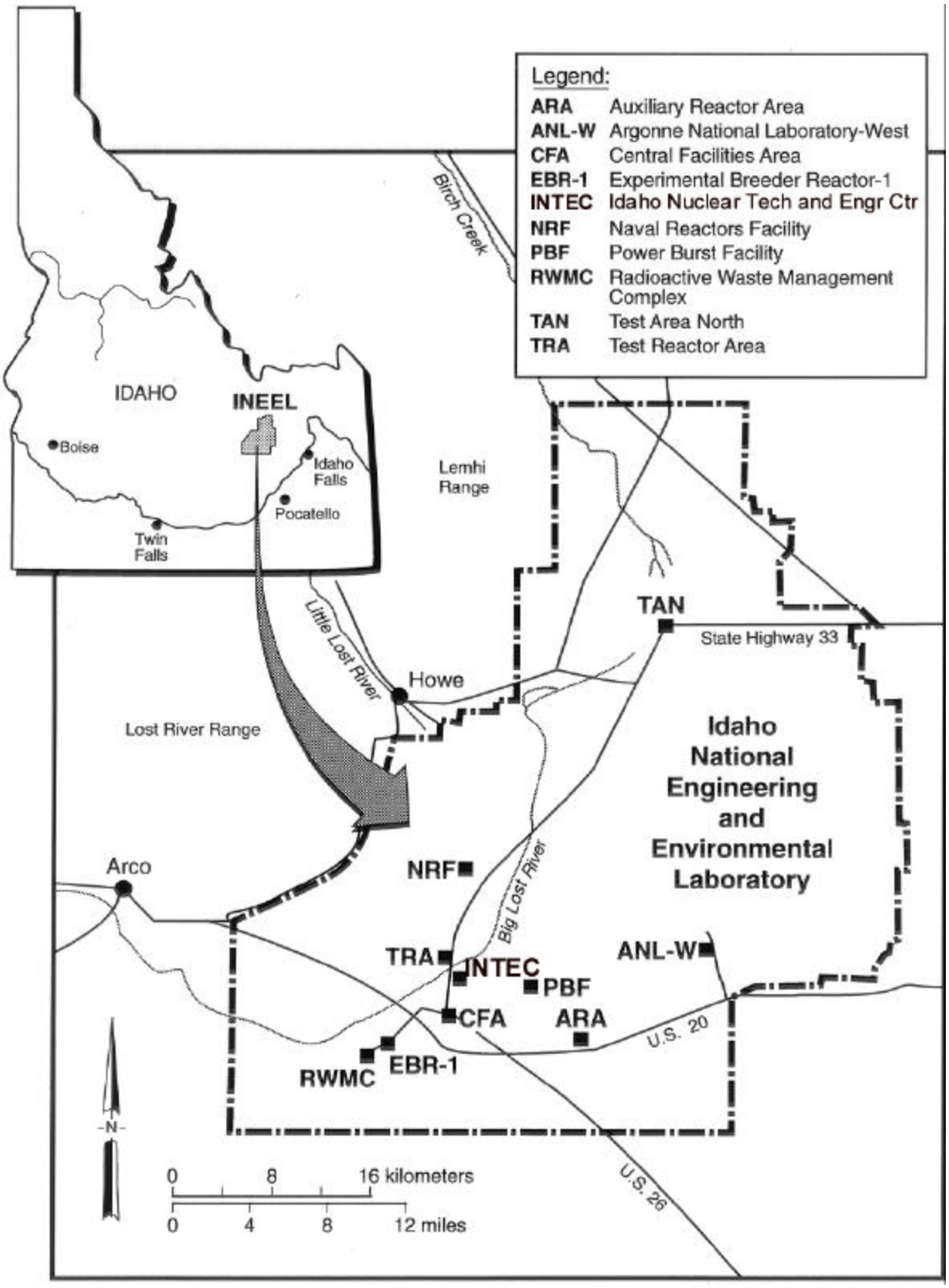

Figure G.3. Idaho National Engineering and Environmental Laboratory and Major Facilities

and heavy metals such as chromium and nickel (Rouse et al. 1993, p. 6-21). The tank waste is extremely acidic, with a pH of less than 1 (Rouse et al. 1993, p. 6-19). The liquid waste has a density of 1.1 to 1.3 g/cm^3 (Rouse et al. 1993, p. 6-19). The waste is composed predominantly of nitric acid and sodium nitrate. Small amounts of fission products and transuranic elements are also in the waste. Some of the major constituents of waste by molarity (nominal) are nitrate, 4.5; sodium, 1.5; acid, 1.3; aluminum, 0.57, and potassium, 0.17. The very basic (high pH) waste in the other site's tanks caused many radioactive and nonradioactive metals to segregate into a complex chemical and physical mixture of liquids, slurries, and sludges. In contrast, the metals and other dissolved material in INTEC's acidic tank waste remain in solution. Other than a few inches of accumulated solids on the bottom of the tanks, the liquid is clear to the bottom of the tanks. This simplifies waste characterization and retrieval compared to other DOE tank sites.

INTEC's tank waste has been divided into two categories: high-level liquid waste and sodium-bearing waste. All of the high-level liquid waste resulting from the dissolution and processing of spent nuclear fuel has been calcined (see calcination description at G.2.3) and is stored in bin sets. Only sodium-bearing waste remains in storage in the tank farm.

G.2.2 Waste Generation at INEEL

Several waste management facilities were built at INEEL. A key facility is INTEC. Building began on this facility in 1951, and it was operating by 1953. This plant received, stored, and reprocessed spent nuclear fuel for the recovery of uranium-235. It is one of eight reprocessing facilities built in the DOE complex. [The others were build at Hanford (five plants) and SRS (two plants).] Most reprocessing was performed on zirconium-clad uranium fuel used in the Navy's propulsion reactors. Significant quantities of fuel clad in aluminum, stainless steel, and graphite were also reprocessed. DOE terminated reprocessing activities in 1992.

Reprocessing began with the receipt of spent reactor fuel; it arrived in shielded casks via truck or rail. The spent fuel was removed from the casks and stored under water at the Fuel Receiving and Storage Building. If the fuel was not suitable for underwater storage due to corrosion or reactivity concerns, it was stored in dry storage facilities.

Next, the fuel was dissolved in either hydrofluoric acid for zirconium-clad fuel or nitric acid for aluminum- and stainless steel-clad fuel. An electrolytic process was employed to speed the dissolution of the stainless steel. The fluoride solutions were complexed with aluminum nitrate so the follow-on processing steps could be carried out with the same equipment used for the other fuel types. At this point the solution consisted of uranyl nitrate and nitrated fission products such as cesium-137, strontium-90, and transuranic elements. For graphite fuel, combustion preceded dissolution. Small quantities of other nuclear fuels were custom processed in specialized on-site hot cell laboratories.

The solution was then treated using a modified PUREX process. This process produced a uranyl nitrate solution and waste solutions. The uranyl nitrate solution was evaporated and denitrated into uranium trioxide granules. These granules were shipped to the Y-12 Plant at the ORR in Tennessee, to be processed into new reactor fuel (Rouse et al. 1993, p. 6-13).

The highly radioactive and chemically concentrated liquid (called raffinate) was collected and transferred to the tank farm, which consists of 11 underground storage tanks, to await further treatment. Low-level liquid wastes from incidental processes were collected and concentrated in an evaporator, which is still in operation. Concentrates from this evaporator are transferred to the tank farm and the evaporator overheads are superheated, filtered, and discharged to the atmosphere through the plant stack.

From FY98 through the year 2000, baseline waste generation modeling shows that site activities will generate about 515,000 gal of sodium-bearing waste. Operation of the calciner will generate about 92,000 gal of calcined solids. About 15,000 gal of sodium-bearing waste are added to the tanks each month from facility decontamination and decommissioning, off-gas system operation, and spent nuclear fuel storage. No HLW has been added to the tanks since reprocessing was terminated in 1992 (TFA 1996, p. A.13). There is no projected generation of HLW at INTEC in the future; the projected generation of sodium-bearing waste through 2005 is 720,000 gal (2.7 M liters). An aggressive waste minimization program has been implemented at INTEC with the goal to reduce this waste generation by at least 35%.

G.2.3 Calcination

Calcination of radioactive waste began in December 1963 at the Waste Calcining Facility, which operated until March 1981. The New Waste Calcining Facility started operation in September 1982 and is still operational. Calcination converts liquid radioactive waste to a solid using a high-temperature (about 900°F) drying process. The solid produced, called calcine, is dry, with the consistency of granulated laundry detergent. Calcination is done because the calcined waste occupies approximately seven times less volume, is more chemically stable, and is safer to store than the liquid waste. Thus, the approximately 1 Mgal (3.7 M liters or ~3,800 cubic meters) of calcine produced at the site represents approximately 7 Mgal (26.5 M liters) of liquid waste calcined since 1963.

To turn the liquid waste into calcine, waste from reprocessing activities is combined with chemical additives to minimize corrosion and produce calcine with the desired physical and chemical characteristics. Then, the mixture is sprayed into a heated fluidized bed of granular solids. (A fluidized bed uses a cushion of hot gas blown through a container to float a powered material as a means of drying.) This evaporates water, nitric acid, and other volatile species and chemically transforms the waste into a dry form consisting primarily of metallic oxides. The calcine is removed from the calciner vessel and pneumatically transported to air-cooled storage bins. The main constituents in the calcined waste by weight percent for zirconium-clad fuel reprocessing waste are calcium fluoride (~54%), zirconium oxide (~24%), aluminum oxide (~15%), calcium oxide (~3%), and boron oxide (~3%) with less than 1 weight percent fission product oxides. The main constituents in the calcined waste by weight percent for aluminum-clad fuel reprocessing waste are aluminum oxide (~94%), sodium oxide (~3%), and boron oxide (~2%) with less than 1 weight percent fission product oxides (Childs et al. 1982, p. 57). The radioactivity in calcine is primarily from cesium-137, strontium-90, and their decay products. Sodium-bearing waste cannot be readily converted to calcine because it has a high sodium and potassium content. During the calcination process, the sodium and potassium form compounds that melt and agglomerate at calcination and bin storage temperatures. Calcination of sodium-bearing waste is achieved by blending with other wastes low in sodium and potassium content or by blending with nonradioactive additives.

G.2.4 Storage Tanks and Calcine Bin Sets at INEEL

Approximately 1.4 Mgal (5.3 M liters) of radioactive liquid waste containing 520,000 Ci of radioactivity are stored as acidic solutions in INTEC's 11 tanks. The amount of waste is not spread evenly among the 11 tanks. Some tanks are close to capacity while others are not. One of the tanks is empty and has been declared a spare tank. The tanks are similar in design, constructed of stainless steel, and contained in underground concrete vaults. Each tank has four to five access risers. Steam jets are used to transport waste from tanks into the process system.

Eight of the 11 tanks can be cooled using cooling coils located along the tank floors and walls. These cooled tanks were used to contain the wastes and fission products (e.g., cesium-137 and strontium-90) from the thermally hottest first- and second-cycle extraction processes. Chemical raffinate from later extraction cycles and LLW evaporator concentrates were stored in the uncooled tanks. The wastes are stored in the tanks until ready for calcination. To date, none of these tanks has leaked waste to the surrounding environment.

The 11 tanks have two different capacities and three different vault designs:

- 9 tanks have capacities of 300,000 gal (1.1 M liters)
- 2 tanks have capacities of 318,000 gal (Rouse et al. 1993) (1.2 M liters)

G.2.4.1 Pillar and Panel Vault Tanks

These five 300,000-gal-capacity (1.1M liter) tanks (WM-182 to WM-186) were built with a primary stainless-steel liner. These tanks are in concrete octagonal pillar and panel concrete vaults (see Figure G.4). The vaults around Tanks WM-182 to WM-184 were built in 1954 with precast concrete components including a precast T-beam roof. The vaults around Tanks WM-185 and WM-186 were modified to increase their structural strength. The tanks have 50-ft (15 meter) diameters, with walls 21 ft (6.4 M) high. Except for Tanks WM-184 and WM-186, all of the tanks are equipped with cooling coils (Rouse et al. 1993, p. 6-17). The tanks were built from 1954 to 1957.

G.2.4.2 Rectangular Vault Tanks

These four 300,000-gal (1.1 M liter) tanks (WM-187 to WM-190) were constructed with a primary stainless-steel liner. They were built within square, concrete cast-in-place vaults (see Figure G.5). Each vault contains two tanks and has a precast T-beam roof. The tanks have 50-ft (15 M) diameters, with walls 21 ft (6.4 M) high. All tanks were equipped with cooling coils. These tanks were built from 1958 to 1964 (Rouse et al. 1993, p. 6-17). Tank WM-190 is empty and is maintained as a spare.

G.2.4.3 Octagonal Concrete Vault Tanks

The two 318,000-gal (1.2 M liter) tanks (WM-180 and WM-181) were built with primary stainless-steel liners and encased in cast-in-place octagonal concrete vaults (see Figure G.6). The tanks have 50-ft (15 M) diameters, with walls 23 ft (7 M) high. One of these tanks, WM-180, has cooling coils; the other

does not. From 1951 to 1952, both tanks were built in the INTEC area. Tanks WM-180 and WM-181 entered service in 1954 and 1953, respectively, and are the oldest tanks on site (Rouse et al. 1993, p. 6-15 and 6-16).

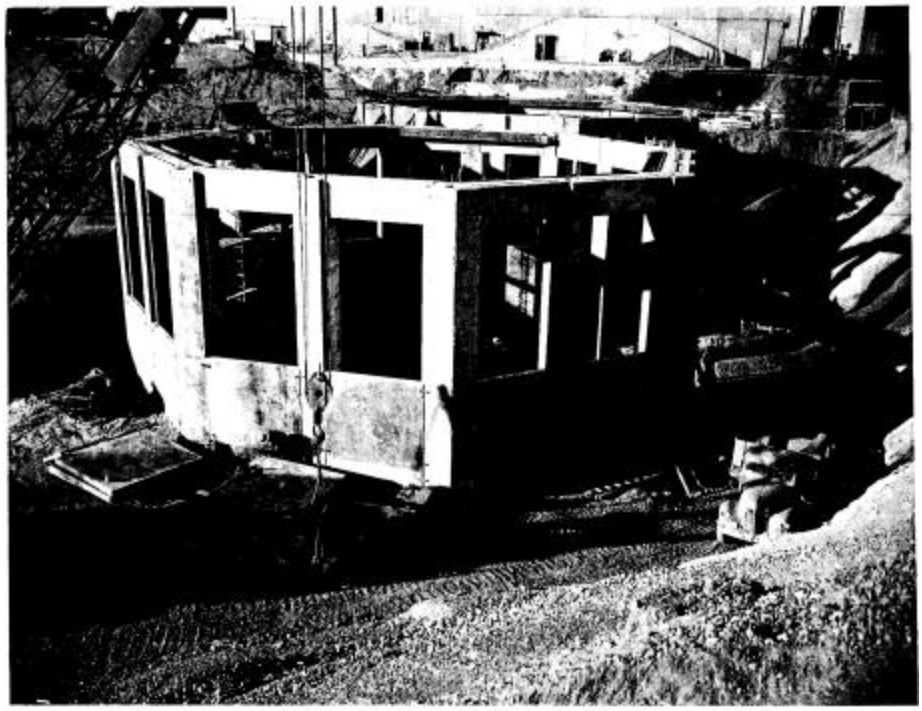

Figure G.4. Octagonal Pillar-and-Panel Vault

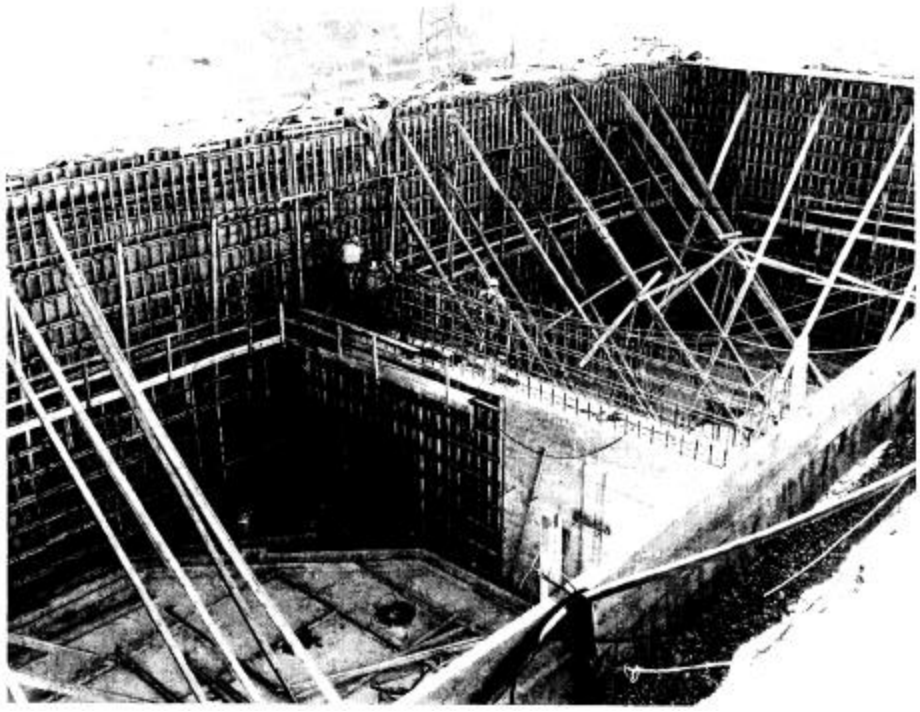

Figure G.5. Square Poured-In-Place Vault

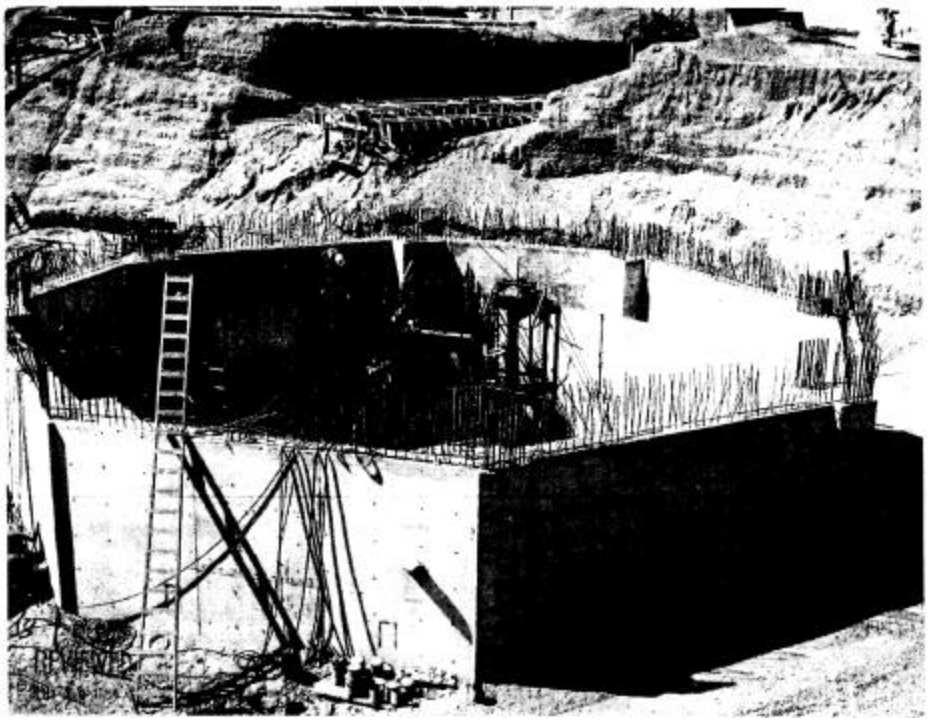

Figure G.6. Octagonal Poured-In-Place Vault

G.2.4.4 Calcine Bin Sets

Approximately 1 Mgal (3.7 M liters or ~3,800 m^3) of calcine containing 24 MCi of radioactivity are stored in seven stainless-steel bin sets enclosed in concrete vaults with walls up to 4 ft (1.2 M) thick. Thus, the calcine contains about 98% of the waste radioactivity at INTEC. The bin sets have a network of monitoring systems that include temperature, pressure, and radiation monitors (Rouse et al. 1993, pp. 6-13 and 6-15). Five of the seven storage facilities are full, the sixth is being filled, and the seventh is empty. The bins have a life expectancy of 400 to 500 years. Radiation doses of 1,000 rem/hr have been measured in the annulus space of these bins (U.S. Congress 1991, p. 45). Calcined waste is not an acceptable form for permanent disposal because of concerns that the dry waste could be easily dispersed. Therefore, the calcined waste will be converted to an acceptable final form before disposal in a geologic repository.

G.2.5 Regulatory Drivers for INEEL

Idaho's major cleanup issues for INTEC are driven by two regulations: the Notice of Noncompliance Consent Order and the Idaho Settlement Agreement. Also, the Accelerating Cleanup plan plays a significant role.

- **Accelerating Cleanup: Paths to Closure, Idaho Operations Office**. (DOE-ID 1998). The plan provides a project-by-project projection of the technical scope, cost, and schedule required to complete all 46 projects at INEEL's remaining cleanup sites.

- **Notice of Noncompliance Consent Order**. The Consent Order, developed by the state, requires DOE's Idaho Operations Office to cease use of the five pillar and panel vault tanks by 2009 and to cease use of the remaining six tanks by 2015. An August 1998 modification to the Consent Order accelerated these dates to 2003 and 2012, respectively.
- **Idaho Settlement Agreement** (Public Service Co. of Colorado Batt). The Batt Settlement Agreement (formally known as the Settlement Agreement between the Governor of Idaho [Philip E. Batt], DOE, and the Navy) requires all high-level liquid waste to be calcined by June 1998, with the remaining sodium-bearing waste calcined by 2012. By 2009, a ROD must be issued that establishes a date for completion of the calcine treatment. (Other treatment alternatives for sodium-bearing waste may be employed to meet the intent of this agreement, in accordance with the High Level Waste Environmental Impact Statement that is currently being finalized). By 2035, DOE must remove all spent fuel from the site and have all HLW road-ready for shipment and disposal at a repository.

To meet these last agreements, the following assumptions have been made. The bulk of the liquid tank waste will be retrieved and calcined, leaving liquid heels in the tanks that will be treated as part of tank closure. Calcine will then be retrieved from the bins and dissolved. After dissolution, the resulting liquid will be separated into high- and low-activity fractions. High-activity waste, containing the cesium-137, strontium-90, and transuranic elements, will be vitrified for disposal. Low-activity waste, containing the radioactive chemicals, will be grouted and disposed. Currently, no agreements or plans have been finalized to close INTEC's tanks or calcine bins.

G.2.6 Milestones for INEEL

Selected milestones in the remediation of INEEL's radioactive waste are shown in Table G.2.

Table G.2. Idaho National Engineering and Environmental Laboratory Milestones

Milestone Title	Completion Date
Commence negotiating a plan and schedule for calcined waste treatment	1999
Commence calcination of sodium-bearing radioactive liquid waste	2001
Cease use of waste tanks in pillar and panel vaults	2003
Issue ROD for treatment of sodium-bearing waste	2009
Complete treatment of sodium-bearing waste	2012
Cease use of waste tanks contained in monolithic vaults	2012
Complete treatment of all high level radioactive waste. Ready for offsite shipment to a repository.	2035

G.3 Oak Ridge Reservation

The Oak Ridge Reservation (ORR), located 25 mi west of Knoxville, Tennessee, was the Manhattan Project's first site for the production of nuclear material (see Figure G.7). This material included small quantities of plutonium-239 and large quantities of uranium-235. The 58-m^2 area was selected in September 1942 for several reasons, including abundant electric power, adequate surface water supply from the Clinch River, inexpensive land, and distance from U.S. population centers. Facility construction began in February 1943 and operations started by November of the same year.

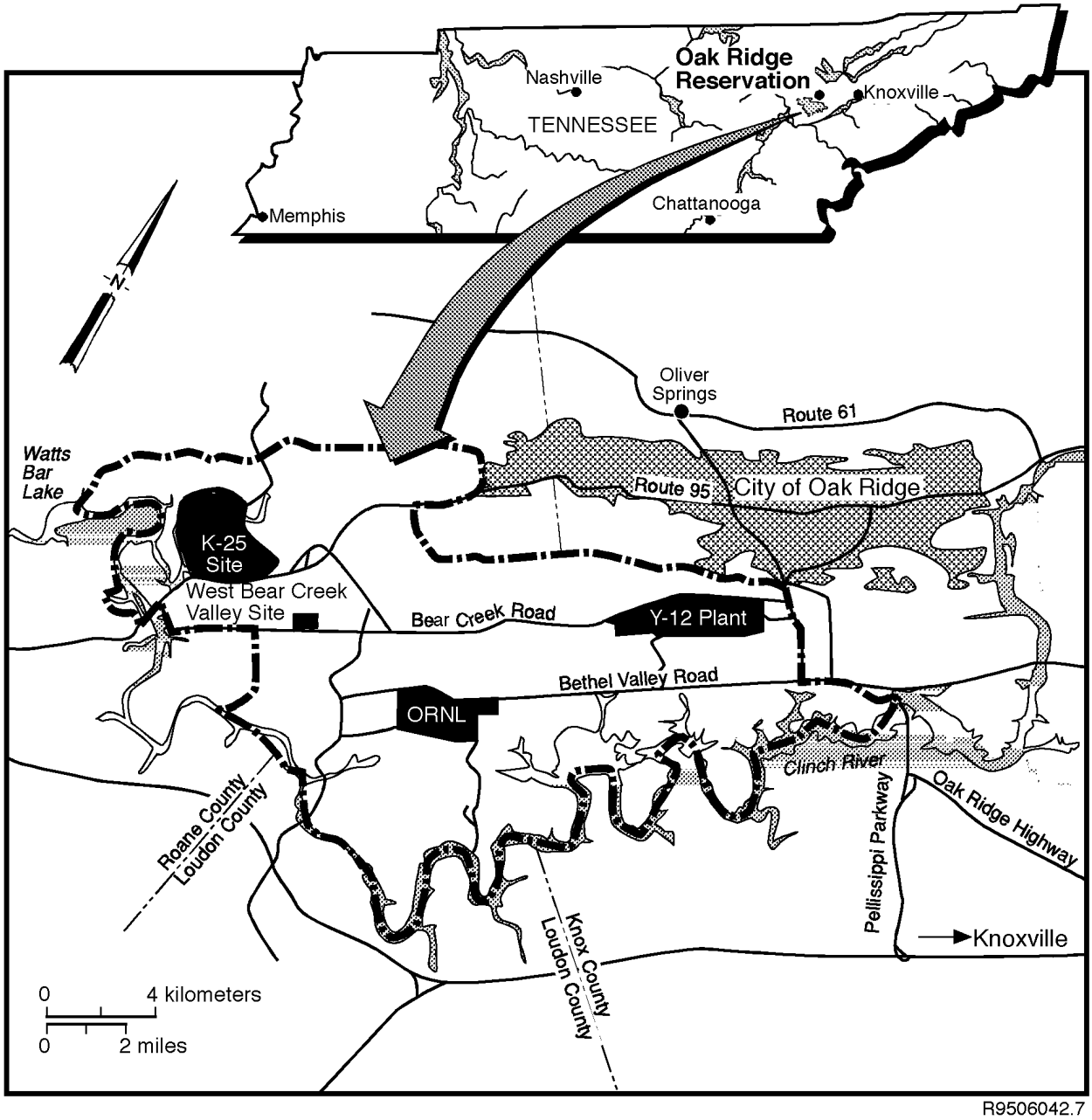

Figure G.7. Oak Ridge Reservation and Major Facilities

Three of the site's major nuclear material production facilities were the X-10 reactor, the K-25 facility, and the Y-12 facility. The X-10 reactor, the world's first graphite-moderated reactor, was capable of producing small quantities (grams) of plutonium-239. This was an air-cooled reactor built between February and November of 1943 that was to have been the prototype for reactors at the Hanford Site in Washington State — the plutonium production site for the Manhattan Project. However, Hanford's reactor design was changed to a water-cooled system. The K-25 facility, built between 1943 and 1946, used gaseous diffusion to separate uranium isotopes. This technology was based on the principle that when uranium is turned into uranium hexafluoride gas and passed through a porous barrier membrane, the heavier uranium-238 isotope moves more slowly than the lighter uranium-235 isotopes. Therefore, the two could be separated, and the uranium-235 isotopes collected and concentrated. In 1985, the K-25 facility was placed on standby and then shut down in 1987. The Y-12 facility, built in 1943, used an electromagnetic process to separate uranium isotopes by their atomic weight. Separation was accomplished using a cyclotron as a mass spectrometer to separate the desired uranium-235 isotope from the bulk of the uranium-238, which makes up naturally occurring uranium. The electromagnetic process was discontinued after World War II.

Over the years, X-10 site operations and research expanded. In 1948, this became known as the Oak Ridge National Laboratory (ORNL). One example of the site's expanding work was the world's first solvent extraction process (REDOX process) for chemically recovering uranium and plutonium from reprocessed spent fuel, pilot-tested at ORNL. Through 1964, the site's primary mission was to produce highly enriched uranium for nuclear weapons. From 1959 to 1969, uranium production shifted to commercial-grade, low-enrichment uranium-235 to support the nuclear power industry. The site also hosted gas centrifuge facilities used to develop and demonstrate uranium-enrichment technologies. These facilities have since been shut down.

G.3.1 Characteristics of Oak Ridge Reservation Tank Waste

Waste in ORR's 34 main tanks is classified as either low-level or TRU mixed waste. This waste was created from several sources, including reactor water cleanup, radiochemical process development and processing areas, facility decontamination, and laboratory operations.

Some ORR tank wastes have physical, chemical, and radiological characteristics similar to HLW at other DOE sites, such as Hanford or SRS. Chemically, the waste is principally sodium nitrate, as is the HLW generated from weapons production activities. However, because the U.S. definition of HLW is based on the waste's origin (waste from processing spent nuclear fuel is classified as HLW regardless of its radioactivity), the site's waste is not high level. Nonetheless, some of the TRU waste in the sludge of some ORR tanks contain as much radioactivity as HLW at other DOE facilities (DOE 1996b).

In addition, because the ORR waste contains both radionuclides (e.g., cesium, strontium, plutonium, uranium, technetium, and ruthenium) and chemicals (e.g., lead, chromium, mercury, and some organic compounds), the waste is classified as mixed.

G.3.1.1.1 Legacy Waste

Approximately 436,000 gal (1.6 M liters) of legacy waste containing 47,300 Ci of radioactivity (mostly cesium-137 and strontium-90) are stored in tanks at ORR (DOE 1996b). About 87% (381,000 gal [1.4 M liters]) of this is liquid LLW. The remaining 55,000 gal (208,000 liters) is sludge containing the bulk of the TRU radionuclides. This legacy waste is typically 10 to 100 times less radioactive than the tank waste at other DOE sites (DOE 1996b).

Legacy waste at ORR was originally acidic. Sodium carbonate, sodium hydroxide, or lime was used to neutralize the waste to avoid rapidly corroding the carbon steel and concrete tank containers. Neutralization caused the heavy metals and transuranic isotopes to precipitate, forming layers of sludge in the bottom of many of the tanks. Most of the TRU elements and over 80% of the fission products are in the sludge (DOE 1996b). The later addition of calcium carbonate and waste evaporation enhanced precipitation, as well as sludge formation. Most of the legacy waste was in 16 Gunite and Associated Tanks (GAAT) and 5 Old Hydrofracture (OHF) tanks prior to recent remediation activities.

G.3.1.2 Active Waste

ORR still generates waste today. This waste is called "active waste" and results from decontamination activities and ongoing research projects. Annually, about 400,000 gal (1.5 M liters) of liquid waste is generated (TFA 1996a, p. A.20). Through evaporation and other processes, this is concentrated to 15,000 gal (56,000 liters) of waste containing 13,000 Ci of radioactivity (DOE 1996b). Over 99% of the radioactivity (primarily cesium-137 and strontium-90) in this waste is from a single facility called the Radiochemical Engineering Development Center. This plant recovers a variety of radioisotopes produced by irradiation of other isotopes. The active waste is stored in thirteen 50,000-gal (189,000 liters) stainless steel tanks: the eight Melton Valley Storage Tanks (MVSTs), five Bethel Valley Evaporator Service Tanks (BVESTs), and six 100,000-gal (378 K liters) stainless steel tanks (MVCI). The MVSTs are also being used to consolidate inactive tank waste for future treatment and disposal.

G.3.2 Storage Tanks at Oak Ridge Reservation

At ORR, 40 tanks hold the bulk of the site's past and current liquid waste (DOE 1996b). Most ORR tanks (34) were constructed in the 1940s and 1950s and had a design life of 20 to 30 years. Six new tanks were built in the late 1990s and began operating in 1998. The tanks were built using a variety of materials; some were made of carbon steel, others were made of concrete reinforced with a steel frame, and still others from stainless steel. The first two building materials are characterized by susceptibility to corrosion from prolonged exposure to chemical waste. ORR has 21 underground storage tanks that are classified as inactive and 19 large tanks classified as active. The inactive tanks are said to contain "legacy waste" from past waste generation and management practices. The 40 tanks are located in five tank farms.

G.3.2.1 Gunite and Associated Tanks

Radioactive and other hazardous chemical wastes have resulted from normal facility operations at ORR. To collect, neutralize, and store these wastes, 12 underground tanks were constructed of gunite

(Figure G.8). Gunite is a mixture of cement, sand, and water sprayed through a nozzle over a steel reinforced framework (DOE 1996a, p. 1). Built between 1943 and 1951, these tanks were removed from

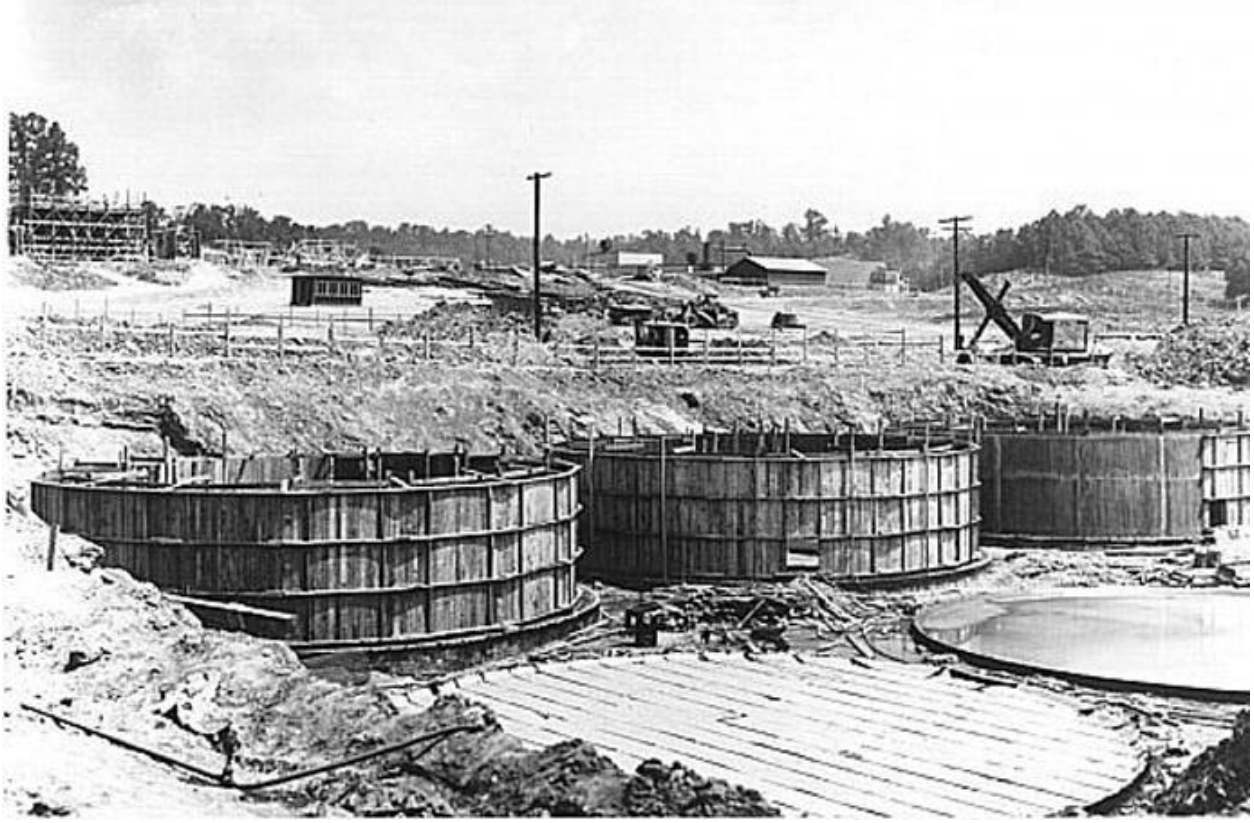

Figure G.8. Gunite Tanks Construction in 1943

Four gunite and four stainless steel tanks (including attached accessory equipment) are located in the North Tank Farm. Six gunite tanks and attached accessory equipment are in the South Tank Farm. Two separate gunite tanks also exist: Tank W-11 (a small tank reaching 8 ft (2.4 M) in diameter with 1,500 gal [~5,500 liters] capacity) and Tank TH-4 (a larger tank with a 20 ft [6 M] diameter and a 17,900 gal [~67,700 liters] capacity) are located in Bethel Valley, but outside the North and South Tank Farms.

None of the 16 GAAT tanks are known to have leaked waste; however, groundwater has leaked *into* the tanks. From 1981 to 1983, most of the sludge was removed from the tanks using hydraulic sluicing and transferred to the operationally active MVSTs. Prior to recent remediation activities, the 354,000 gal (1.3 M liters) of supernate in the 16 GAATs was low-level radioactive waste, while the 88,700 gal (~337,000 liters) of sludge was TRU waste. Approximately 18,000 Ci of radioactivity (75% in the sludge waste) exist in the tanks. Less than 1 ft (.3 M) of sludge remained in each tank, although a few were reported to contain several feet/meters of sludge (Falter et al. 1995, p. 2). Five of the gunite tanks contained about 99% (mostly strontium-90) of the radioactivity stored in all of the gunite tanks. Radiation levels were up to 100 Rad/hr at the waste surface (Falter et al. 1995, p. 1). Beginning in 1998, TFA-developed technologies were used to remove the bulk of the sludge waste from the GAAT tanks.

G.3.2.2 Old Hydrofracture Facility Tanks

The OHF was used from 1963 to 1980 for the subsurface disposal of radioactive waste. Intermediate-level radioactive waste was blended with cement and other additives to form a grout. This grout was injected underground into a shale layer (DOE 1996b). Within the fractures in the shale, the grout hardened into thin, horizontal sheets several hundred meters wide (DOE 1994). A "New" Hydrofracture Facility was built and was used from 1980 to 1983. Hydrofracture disposal of waste ceased in 1984 and is no longer considered an acceptable disposal option in the U.S.

The tanks that held waste to be processed and disposed of at the OHF are made of carbon steel. These five tanks vary in size from 13,000 to 25,000 gal (~49,000-94,000 liters). In 1997, these tanks contained a total of 42,900 gal (162,000 liters) of liquids and 9,800 gal (37,000 liters) of sludge from previous hydrofracture operations. In 1998, the bulk of the waste was removed with the Borehole Miner and transferred to the MVSTs.

The OHF tank liquids contained about 800 Ci of mostly cesium-137. The sludge contained 28,500 Ci of strontium-90, plus TRU such as plutonium-238/239, americium-241, and uranium-233. The liquid and sludge in the OHF tanks contained a variety of constituents; the liquid included mercury and chromium, and the sludge contained cadmium, chromium, lead, and mercury.

G.3.2.3 Melton Valley Storage Tanks

The eight MVSTs are cigar shaped, measuring 12 ft (3.6 M) from floor to roof and 61.5 ft (18.7 M) from end to end. The tanks are contained in stainless-steel vaults equipped with sumps and liquid level detectors. Each stainless-steel tank has the capacity to hold 50,000 gal (189,000 liters). As of 1997, the tanks contained 309,000 gal (1.1 M liters) of waste and 126,500 Ci of radioactivity. The waste is in the form of supernate and sludge. In the supernate, the major radioactive contaminants of concern are strontium-90, cesium-137, technetium-99, and ruthenium-106 (DOE 1996b, p. A.20). While the composition of the supernate varies, a typical chemical composition is a 4 to 5 molar sodium nitrate solution with large concentrations of soluble compounds such as potassium nitrate and sodium chloride. The sludge, which contains TRU elements, makes up 35% of the waste volume and 80% of the radioactivity in the MVSTs. Chemically, the sludge contains insoluble compounds, such as aluminum hydroxide, calcium phosphate, and bentonite. The volume and composition of the waste in the MVSTs, which contain waste from current site activities, is changing as waste from other tanks is transferred to these tanks for final treatment.

G.3.2.3.1 Bethel Valley Evaporator Service Tanks

At the Bethel Valley Evaporator, five 50,000-gal (189,000 liters) stainless steel tanks were built in 1979 to hold waste before it was transferred into the evaporator. The cylindrical tanks, called the BVEST, are approximately 12 ft (3.6 M) high and 61.5 ft (18.7 M) long, which would cover roughly two-thirds the length of a basketball court. The tanks are filled with numerous pipes and other obstructions. As of 1997, the tanks held about 135,000 gal (511,000 liters) of waste made up of 96,000 gal (~363,000 liters) of supernate and 39,000 gal of sludge. A total of 12,000 Ci of radioactivity existed in these five tanks at that time. Over the years, chemical reactions in the tanks have caused solids to precipitate.

In addition to waste destined for the evaporator, the tanks contain "evaporator bottoms." Evaporator bottoms are the residual wastes from the evaporator or, stated another way, the solids that do not evaporate. For years, the bottoms were pumped back into the tanks after each evaporator campaign and formed a layer of sludge. In 1998 and 1999, the sludge was removed from three BVESTs using the Fluidic Pulse Jet Mixer.

G.3.3 Regulatory Drivers for ORR

The regulatory drivers for remediating ORR tank wastes are as follows:

- **Federal Facility Agreement for the Oak Ridge Reservation** (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. This agreement establishes requirements under CERCLA for the management of tanks. Per this agreement, DOE must remove from service all tanks that operate without secondary containment. Tanks with secondary containment may continue to operate.
- **Tennessee Department of Environment and Conservation Commissioner's Order for ORR Site Treatment Plan**. This requires that Resource Conservation and Recovery Act (RCRA) land disposal restricted waste must be treated for disposal per the agreed upon schedule.
- **Oak Ridge Accelerated Cleanup Plan** (DOE-OR 1997). 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). Privatized treatment will be an integral part of achieving accelerated clean-up goals.

G.3.4 Milestones for ORR

Selected ORR milestones are shown in Table G.3.

Table G.3. Oak Ridge Reservation Milestones

Milestone Title	Completion Date
Complete Bethel Valley Remedial Action	2006
Complete White Oak Creek Remedial Action	2006
Complete legacy TRU waste treatment	2005
Complete legacy mixed and low-level waste treatment	2006

G.4 Savannah River Site

Construction of the 310-mi^2 SRS, in South Carolina, began in 1951. The site is located approximately 12 mi south of Aiken, South Carolina, and 13 mi southeast of Augusta, Georgia (see Figure G.9). The site borders the Savannah River and has several streams running through it. The site's primary original missions were to produce tritium and plutonium-239 for nuclear weapons, plutonium-238 to support the space program, and special medical isotopes. As a result, 36.1 metric tons of weapons-grade plutonium were produced (roughly one-third of the total 104 metric tons produced in U.S. government reactors; the

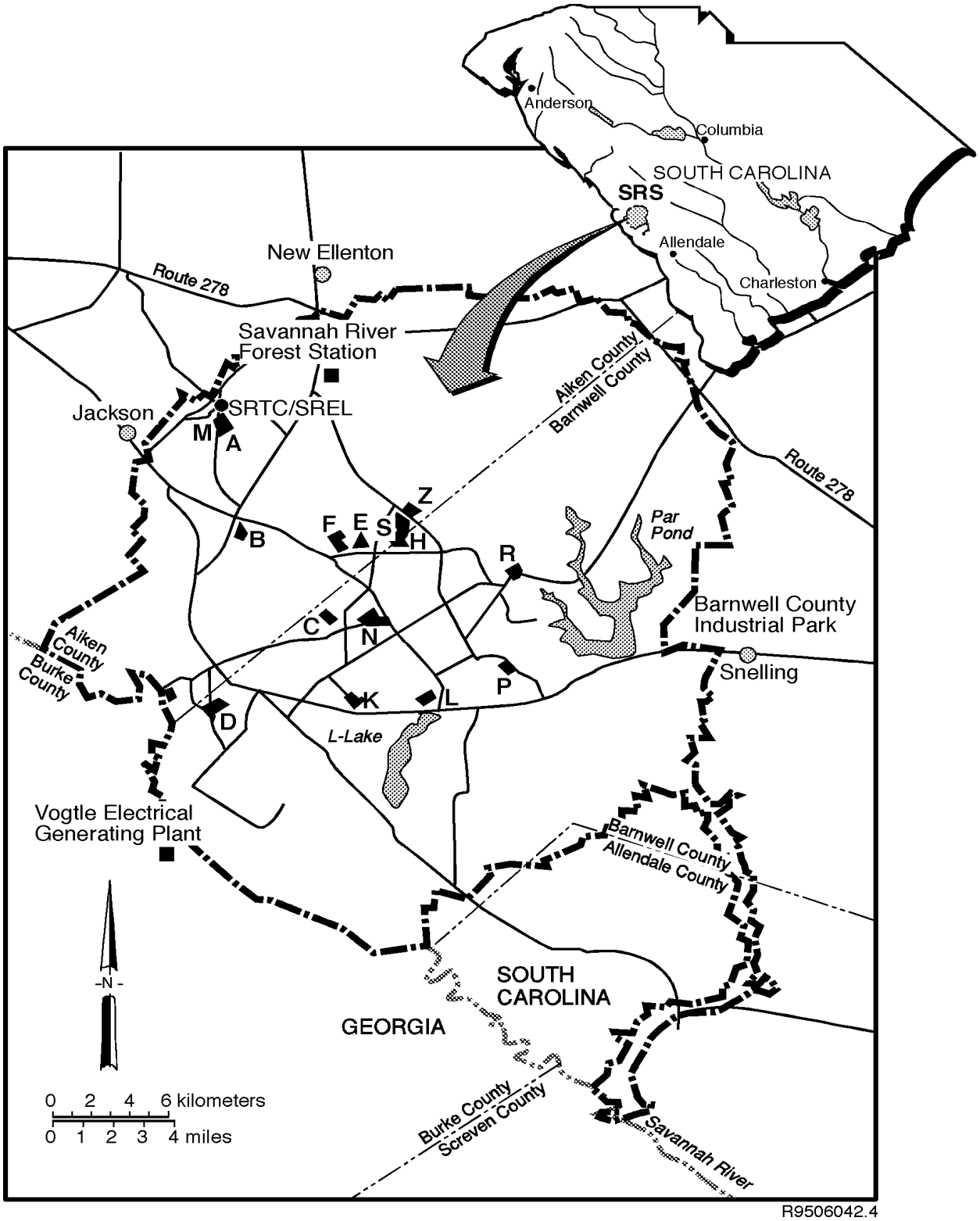

Figure G.9. Savannah River Site and Major Facilities

rest came from Hanford) (Usdin 1996). In 1991, SRS stopped producing nuclear materials for weapons. However, the spent nuclear fuel reprocessing facilities still operate on an as-required basis to supply, for example, plutonium-238 to the National Aeronautics and Space Administration for powering deep space probes. Today, the site missions are management and clean up of the nuclear wastes that resulted from its production mission, maintenance of the nuclear weapons stockpile through management of tritium resources, and management of excess nuclear materials to support nuclear nonproliferation initiatives.

Because of its nuclear production work, SRS contains numerous facilities — from office buildings to nuclear reactors. Five heavy-water-moderated reactors, which produced plutonium and tritium, and a heavy-water production plant are on the site. Two reprocessing facilities were built (F Canyon and the H Canyon), along with supporting structures, to extract plutonium and uranium from irradiated nuclear fuel. Two tank farms with a total of 51 large (750,000-1,300,000 gallon capacity) (2.8 M – 5 M liters) storage tanks were constructed to store the HLW generated by the reprocessing facilities.

G.4.1 Characteristics of Savannah River Site Tank Waste

Soluble chemical constituents are primarily sodium salts such as sodium nitrate (49 wt%), sodium nitrite (12 wt%), sodium hydroxide (13 wt%), sodium-aluminum tetrahydroxide (11 wt%), sodium sulfate (6 wt%), and sodium carbonate (5 wt%). The chemical composition of the insoluble sludges are primarily aluminum oxide (33 wt%), iron oxide (30 wt%), silicon oxide (6 wt%), sodium nitrate/nitrite salts (6 wt%), and zeolite (4 wt%) (WSRC 1995).

The remainder of the waste will go to the Effluent Treatment Facility for treatment and release into the environment, or to the Saltstone Facility for conversion into saltstone, a low-level waste form suitable for on-site disposal in concrete vaults. All of the sludge and about 27% of the salt and supernate will go to the Defense Waste Processing Facility (DWPF) where it will be converted to glass. The remainder of the waste will go to the Effluent Treatment Facility for treatment and release into the environment, or to the Saltstone Facility for conversion into grout. A discussion of the major facilities at SRS is helpful in understanding the characteristics of the wastes.

G.4.2 Waste Generation at Savannah River Site

The F and H Area reprocessing plants started operating in 1954 and 1955, respectively. They have not been officially shut down, as have the five Hanford reprocessing plants. Both SRS reprocessing plants used the PUREX process and variations of that process to remove fission products from aluminum-clad spent fuel. The F Canyon reprocessed natural uranium (99.3% by weight uranium-238 and 0.7% uranium-235) while the H Canyon reprocessed more enriched uranium (higher uranium-235 content). Waste streams from each canyon included uranyl nitrate and two forms of plutonium nitrate (uranium and plutonium in nitric acid solutions). Further processing was required to convert the plutonium nitrate into plutonium metal. Four evaporators (two in the F Area and two in the H Area) located near the respective tank farms were used to evaporate liquids from the tank waste into a chemically concentrated slurry. After evaporation, the slurry was returned to the tanks. In 1997, two evaporators were in operation (one each in the F and H areas). Each evaporator processes between 3 and 3.75 Mgal (10-14 M liters) of supernate per year. The newly constructed Replacement HLW Evaporator has not yet been commissioned and operations are not expected to begin until Spring 2000. This new evaporator is expected to process about 9.7 Mgal (36.7 M liters) of supernate per year. Some 82 Mgal (310 M liters) of

tank waste have been generated at SRS since the 1950s. Evaporation has reduced this volume by 60% to about 34 Mgal (128 M liters).

Beginning in 1955 and 1957, tritium (a form of hydrogen gas) was separated and processed in the site's F and H Areas, respectively. Tritium is released into the center of a nuclear weapon's plutonium core just before detonation. It supplies a pulse of extra neutrons for boosting the weapon's explosive power. The result is a thermonuclear explosion. Essentially all the tritium in the U.S. military arsenal was produced at SRS, which produced an estimated 500 lbs of tritium (International Physicians 1995, p. 249).

Tritium in the nation's weapon stockpile must be replenished continually because it has a half-life of only 12.3 years. In the past, irradiated lithium-aluminum targets were processed to separate tritium from other materials; this tritium was then purified. Today, tritium is recycled from existing weapons. All DOE tritium recycling work is conducted at SRS.

G.4.3 Storage Tanks at Savannah River Site

The 51 underground tanks at SRS (two have been closed) contain about 34 Mgal (128 M liters) of HLW. An estimated 470 MCi of radioactivity exist in this waste. Some 99.4% of this radioactivity is from approximately even contributions of cesium-137 and strontium-90, plus their decay products.

Figure G.10. Saltstone Vaults Under Construction

The waste storage tanks were built from 1951 to 1981. They are located in the F Area (22 tanks) and H Area (29 tanks) tank farms. The tanks were built with three different sizes and four designs:

- 12 have capacities of 750,000 gal (2.8 M liters)
- 4 have capacities of 1.03 Mgal (3.8 M liters)
- 35 have capacities of 1.3 Mgal (5 M liters)

Although tank designs are labeled Types I through IV at the site, the labeling system does not denote the chronological order in which the tanks were built. All but the Type IV tanks are equipped with cooling coils to remove the heat generated by radioactive decay of the waste stored in the tank.

G.4.3.1 Type I Tanks

These twelve 750,000-gal (2.8 M liters) tanks were built from 1951 to 1953 in the H and F Area farms. They were placed in service in 1954. These tanks consist of a ½-inches thick primary carbon-steel liner that is 75 feet (22.8 M) in diameter and 24.5-feet (7.5 M) high set within a steel pan that is 5-feet (1.5 M) deep and 80 feet (~24 M) in diameter. This pan provides partial secondary containment for the tank in case of leakage. A reinforced concrete vault surrounds the tank system and provided both structural support and radiation shielding. Twelve concrete-filled ½-inch (1.3 cm) thick carbon-steel columns inside the tank support the roof. The concrete wall and roof are 22-inches (56 cm) thick. The base slab which supports the tank is 30-inches (76 cm) thick and the entire tank system is covered with approximately 9 feet (2.7 M) of earth overburden that provides additional radiation shielding. Tank cooling is provided by 34 vertical, parallel cooling water coils supported by the roof and 2 horizontal cooling coils across the bottom of the tank. Five of these tanks have leaked waste into the secondary steel liner. An estimated 27% (127 MCi) of the site's tank waste radioactivity and 12% (4 Mgal [15 M liters]) of the site's tank waste volume is contained in these 12 tanks.

G.4.3.2 Type II Tanks

These four 1.03-Mgal tanks were built in the H Area between 1955 and 1966. The first Type II tank was placed in service in 1956. These tanks consist of a ½-inch (1.3 cm) thick (in some places thicker) primary carbon steel liner that is 85 feet (26 cm) in diameter and 27-feet (8.2 M) high set within a steel pan that is 5-feet (1.5 M) deep and 90 feet (22.4 M) in diameter. This pan provides partial secondary containment for the tank in case of leakage. A reinforced concrete vault surrounds the tank system and provided both structural support and radiation shielding. One central concrete-filled ½-inch (1.3 cm) thick carbon steel column inside the tank supports the roof. The concrete wall is 33-inches (84 cm) thick, the roof is 22-inches (56 cm) thick, and the base is 42-inches (106.6 cm) thick. The thickness of the concrete roof provides adequate radiation shielding so there is no earth overburden. Tank cooling is provided by 40 vertical, parallel cooling water coils supported by the roof and 4 horizontal cooling coils across the bottom of the tank. All four Type II tanks are known to have leaked waste. An estimated 8% (38 MCi) of the site's tank waste radioactivity is in these tanks., which contain about 4% (1.4 Mgal [53 M liters]) of the site's tank waste volume.

G.4.3.3 Type III Tanks

These 27 tanks each have a capacity of 1.3-Mgal and contain the majority of the waste at SRS. These tanks were built with a ½-inch (1.3 cm) thick (in some places thicker) primary carbon steel liner that is 85 feet (26 M) in diameter and 33-feet (10 M) high surrounded by a full-height carbon steel secondary containment (90 feet [27 M] in diameter) that provides full secondary containment for the tank in case of leakage. A reinforced concrete vault surrounds the tank system and provides both structural support and radiation shielding. One central concrete column inside the tank supports the roof. There is an annular space between the concrete column and the inner carbon-steel tank wall. The concrete vault wall is 30-inches (76 cm) thick, the roof is 48-inches (121 cm) thick, and the base is 43-inches (109 cm) thick. The thickness of the concrete roof provides adequate radiation shielding so there is no earth overburden. Tank cooling is provided by a combination of cooling coils and forced air. There are differing designs of cooling coils. Some tanks have 23 permanently installed vertical cooling water coils while others have insertable-type cooling coils varying in number from tank to tank. All Type III tank systems have grooved channels in the concrete vault beneath the tank floor for forced air cooling of the tank bottom. All 27 Type III tanks were built in the H and F Areas from 1967 to 1982, with the first tank placed in operation in 1969 (Rouse et al. 1993) (see Figure G.11). Though none of these tanks are known to have leaked, there has been minor water leakage *into* two tanks. Most of the site's tank waste radioactivity (64% or 300 MCi) and tank waste volume (77% or 26.2 Mgal[99 M liters]) is contained in these 27 tanks.

The Type III tanks still receive small amounts of HLW from the site's limited production activities. Two types of waste are being sent: high-heat waste, which contains most of the radionuclides and must be aged in a high-heat waste tank before evaporation; and low-heat waste. After the waste is put in the Type III tanks, it separates into a bottom sludge layer and an upper layer of salts dissolved in water

Figure G.11. Type III Tank Construction in 1980

(supernate and saltcake). Seven of the Type III tanks are used for waste processing or feed supply (TFA 1996a, pp. A.24 and A.25). However, SRS plans to revert two of these tanks back to waste storage service in order to provide much needed additional storage space in the tank farms for on-going waste receipts from the reprocessing facilities and recycle receipts from the DWPF through FY10. At this time, startup of salt processing operations will begin to reduce waste volumes in the tank farms.

G.4.3.4 Type IV Tanks

Each of these eight tanks have 1.3-Mgal (4.9 M liters) capacities. These tank were built with a 3/8-inch (~3/4 cm) thick (in some places thicker), 85-foot (26 M) diameter and 34-foot (10 M) high carbon steel liner for the walls and floor of the tank, and a concrete domed roof 6 to 10 inches (15 – 25 cm) thick that rises an additional 11 feet (3.5 M). A multiple-layer concrete vault surrounds the primary tank wall. The inner concrete wall is 11-inches (26 cm) thick and is surrounded by a 4-inch (10 cm) thick high-strength steel-reinforced concrete wall that enhances its load bearing capacity. A 4-inch (10 cm) thick concrete base slab supports the tank bottom. Beneath the base slab, the entire tank is supported by a 4-inch (10 cm) thick concrete working slab. The tank top is covered with a minimum of 32-inches (81 cm) of earth overburden that provides additional radiation shielding. There is no secondary containment structure and no tank cooling system. Four Type IV tanks were built in the F Area in 1958, and from 1959 to 1961, four additional tanks were built in the H Area. The Type IV tanks were first

placed into service in 1959. Less than 1% (<5 MCi) of the site's tank waste radioactivity and 7% (2.4 Mgal [9 M liter]) of site's tank waste volume is contained in these tanks. Monitoring records suggest that a small amount of water has leaked *into* these tanks. Waste was removed from one Type IV tank because of a leak that developed in its carbon steel liner. Waste was removed from two other Type IV tanks, and the tanks were grouted and closed.

G.4.4 Waste Processing at Savannah River Site

G.4.4.1 Waste Pretreatment

Tank waste pretreatment at SRS consists of two main steps: sludge washing and cesium separation from HLW salt solutions. Sludge washing is performed at the Extended Sludge Processing Facility which consists of three Type III storage tanks that were converted to sludge processing service. The purpose of the wash is to remove soluble salts and aluminum from the sludge. After washing, the sludge is transferred to the DWPF for vitrification. SRS is currently washing and vitrifying HLW sludge.

Three promising cesium separation processes for application at SRS are under investigation through a technology development program managed by the Tanks Focus Area. The purpose of this program is to identify the most viable technology to separate cesium (the main radioactive constituent) from the salt component of HLW for application at SRS. The concentrated cesium stream from salt waste pretreatment would be sent to the DWPF for vitrification. The decontaminated salt stream from pretreatment would be sent to the Saltstone facility. Presently, SRS plans to begin cesium separations operations in the year 2010, following selection of the favored cesium separations technology, and design, construction and operational testing of a salt processing facility.

G.4.4.2 Defense Waste Processing Facility

The DWPF contains the vitrification processing equipment for converting highly radioactive sludge and salt solutions into glass (see Figure G.12). These waste materials are mixed with sand-like borosilicate glass (called frit) and sent to the plant's 65-ton steel and ceramic melter. Following 13 years (1983-1996) of construction and testing, the DWPF began processing HLW in March 1996.

In the melter, electricity is used to heat the waste and frit mixture to 2100°F. At this point, the mixture is molten. The molten mixture is poured in a pencil-thin stream into a stainless steel canister to cool and harden. It takes about 20 hours to fill one canister. Each canister is 2 ft (.6 M) wide by 10 ft (3 M) long and weighs about 2.5 tons when full. The exterior of each canister is blasted with abrasive to remove any contamination, then welded shut. The canister is then taken to a storage facility and lowered into an underground concrete vault. As of September 1999, 710 canisters of radioactive glass were produced.

It will take approximately 25 years (until the year 2023) to vitrify all of the HLW currently in SRS's tanks. The canisters will remain onsite until a geologic repository opens.

Figure G.12. Defense Waste Processing Facility

G.4.4.3 Saltstone Facility

The Saltstone Facility, operating since 1990, processes and disposes of the chemical salt solution (which contains low levels of contamination) coming from the pretreatment of tank waste. This salt solution is blended with cement (10%), furnace slag (45%), and flyash (45%). After these materials are mixed with the chemical salt solution, the resultant grout mixture (with a consistency resembling latex paint), is pumped to a large concrete vault to harden (or cure). The hardened material is called saltstone. Approximately 200 Mgal (757,000 m^3) of solidified saltstone will be produced. Of the original SRS tank waste radioactivity, all the saltstone will contain less than one-hundredth of 1% (about 20,000 Ci, mostly technetium-99).

The soluble salts mixed with the grout are mostly sodium nitrate. These salts make up about 93% of the 34 Mgal (128 M liters) of HLW stored at SRS.

Plans are in progress to build 15 more saltstone vaults, each covering about 2.7 acres. Fourteen vaults will have 12 storage cells inside, and one will be designed with six cells. Each cell is 24 ft (~7 M) deep, 100 ft (~30.5 M) long, and 100 ft (~30.5 M) wide. After filling, each vault will be capped with concrete and overlaid by an engineered barrier of earth, clay, and a commercially available polymer roofing material.

G.4.5 Regulatory Drivers for Savannah River Site

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

- **Final EIS Defense Waste Processing Facility and Supplemental EIS** (DOE SRS 1982; DOE-SRS 1994). The ROD from the EIS (47 FR 23801) documents the decision to construct and operate the DWPF. 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 DWPF. The ROD (60 FR 18589) was issued in April 1995 to complete startup testing and begin operation of the DWPF.
- **Savannah River Federal Facility Consent 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 ROD 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 DWPF.
- **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 DWPF as the preferred treatment option for treating liquid HLW.

G.4.6 Milestones for Savannah River Site

Selected SRS milestones are shown in Table G.4.

Table G.4. Savannah River Site Milestones

Milestone Title	Completion Date
Startup Salt Waste Processing	2010
Start Shipping Canisters to the Federal Repository	2015
Complete Closure of 24 Old-Style Tanks	2019
Waste Removal Complete from All Tanks	2024
Sludge Processing Complete	2024
Salt Processing Complete	2024
Complete Shipping Canisters to the Federal Repository	2026
Complete High-Level Waste Management Activities	2027

G.5 West Valley Demonstration Project

The West Valley Demonstration Project (WVDP) is located on a 200-acre site 30 miles south of Buffalo, New York (see Figure G.13). The site is owned by the state of New York, managed by the DOE, and operated by West Valley Nuclear Services Co. under contract for the project.

The project is at the site of a commercial nuclear fuel reprocessing plant originally built and operated by Nuclear Fuel Services Company, Inc. (NFS). The facility was completed and first operated in 1966. In 1972, seven years after operations began, production ceased mainly because of unsuccessful efforts to expand the facility. During the operating period, NFS generated approximately 600,000 gal (2.271 m^3) of liquid HLW. After a period of inactivity, the operating contractor decided against pursuing renewal of their operating permit. In 1980, with the passage of the West Valley Demonstration Project Act (Act) by the United States Congress, DOE was charged with the responsibility to implement a program demonstrating the feasibility of converting liquid high-level radioactive waste into a solidified form acceptable for transportation and eventual disposal. Vitrification as a borosilcate glass was selected as the solidification method as a result of a recommendation by the National Academy of Sciences.

Commencing in the early 1980s, many existing facilities were modified and new facilities constructed to meet the demonstration project mission of HLW vitrification. On July 5, 1996, WVDP filled its first canister of vitrified HLW. As of July 2000, the project has removed approximately 98% of the waste from the tanks and produced 246 HLW canisters.

Figure G.13. Aerial View of West Valley Demonstration Project

G.5.1 Characteristics of WVDP HLW

The HLW streams at WVDP have been stored in an underground tank farm facility (see Section G.5.2) for an average of 30 years. This waste resulted from the reprocessing of approximately 640 tons of spent nuclear fuel. In addition to the uranium and plutonium products, the process created 2,200 cubic meters (600,000 gal) of high-level liquid PUREX waste and 30 cubic meters (8,000 gal) of thorium extraction (THOREX) waste.

Prior to being placed in storage, the PUREX waste was neutralized with sodium hydroxide. Neutralization resulted in a sludge layer of insoluble hydroxides in the bottom of the HLW storage tank. A liquid, supernatant layer remained above the sludge. Strontium-90 and TRU elements were the predominant radionuclides in the sludge, and cesium-137 was the predominant radionuclide in the supernatant. Acidic THOREX waste was stored as a single-liquid phase.

To prepare for vitrification of the waste and minimize the number of HLW canisters produced, the project used zeolite to separate cesium-137 from the supernatant. The process resulted in greater than 99% retention of the cesium-137. It allowed the largely non-radioactive sodium and other salts detrimental to vitrification to be removed and solidified in cement. After removal of the supernatant, the remaining sludge was further processed through a series of sludge washes. The HLW holding tank was repeatedly filled with a solution of demineralized water and sodium hydroxide. This solution was also processed through zeolite to allow removal of accumulated salts, while retaining the cesium-137. As the zeolite was expended, it was placed into a spare HLW storage tank for later processing.

To complete pretreatment and consolidate the waste for vitrification, the acidic THOREX waste was combined with the remaining sludge and washed to remove salts. The majority of the zeolite was moved from storage in the spare HLW tank to the primary tank. This pretreatment process resulted in an estimated 90% reduction of canisters required to contain the remaining HLW volume destined for vitrification processing.

Nearing the end of FY2000, the bulk of the HLW and zeolite has been removed and vitrified. WVDP HLW operations are focused on retrieving the remaining zeolite and small amounts of sludge.

G.5.2 Storage Tanks at WVDP

The original fuel reprocessing plant included four underground storage tanks. Tanks 8D-1 and 8D-2 are single-shell carbon-steel tanks, each having a capacity of about 740,000 gal (2.8 M liters). Each tank is contained in a concrete vault with a pan (see Figure G.14). Tank 8D-2 was used to store waste while Tank 8D-1 was a spare. Tanks 8D-3 and 8D-4 are single-shell, stainless-steel, 13,500-gal (51,000 liters) tanks used to contain wastes from the THOREX process. Tank 8D-4 was the primary tank, and Tank 8D-3 was the spare. A concrete containment vault, buried 8 feet underground, acts as secondary containment for the second set of tanks. Prior to vitrification, the PUREX waste and the majority of the THOREX waste and zeolite media used in pretreatment were consolidated in Tank 8D-2.

Figure G.14. Primary Carbon-Steel Tank Construction in Early 1960s

G.5.3 Remediation and Closure Costs

Phase I of site remediation involved the vitrification of HLW, i.e., the transformation of liquid HLW into a solidified form. This was accomplished using a slurry-fed ceramic melter. The vitrified HLW product is being stored on-site until a federal repository becomes available. Phase II remediation will incorporate decontaminating and decommissioning of facilities, tank farm disposition and transportation of vitrified and other project waste to a permanent storage location.

When the WVDP is completed, the DOE will transfer custody of the site back to the State of New York. Several alternatives for disposition of project facilities are being discussed including: 1) removal of all structures and off-site disposal of all wastes, 2) on-site storage of some wastes indefinitely, and 3) disassembly and entombing of process buildings and backfilling of the HLW tank farm with low density concrete (grout).

The total Phase I system cost for WVDP was estimated to be $1.394 billion. In June 1998, the project completed Phase I ahead of schedule and under budget. The Phase II costs will be based upon the pending ROD of the EIS. Current lifecycle estimates for the WVDP, as contained in the Integrated Planning, Accountability, and Budgeting System Planning Module, has project decontamination completing in FY2015 with final HLW canister shipping and storage facility decontamination occurring between 2036 and 2041. The driver for prolonged completion of the DOE's responsibilities under the Act is the issuance of the Programmatic EIS Record of Decision for HLW (August 1999) which states that all sites with HLW shall retain the waste on-site until a federal repository is available. The distribution of costs by waste management activity are provided in Table G.5.

G.5.4 Regulatory Drivers for WVDP

West Valley Demonstration Project Act of 1980 (Congress 1980) - This Act charges DOE with the solidification of the liquid HLW and cleanup of the HLW tanks and other contaminated facilities at the WVDP. Additionally, the Act requires that DOE develop containers suitable for permanent disposal and the transportation of the solidified HLW to an appropriate federal repository.

Table G.5. West Valley Demonstration Project System Costs

		Through 2000	To Go	Total
PBS OHWV01	HLW Vitrification and High Activity Waste Processing	771	74	845
PBS OHWV02	Site Transition, Decommissioning, and Project Completion	219	1871	2090
PBS OHWV03	Spent Nuclear Fuel	19	13	32
PBS OHWV04	Project Management/Site Support	580	473	1053
	Total DOE Costs	**1589**	**2431**	**4020**

- 1980 Cooperative agreement between DOE and NYSERDA, which defines their respective responsibilities and establishes the conditions under which DOE may use certain facilities at the Western New York Nuclear Services Center. The agreement also establishes cost sharing and other contractual conditions.

- 1991 Supplemental agreement between DOE and NYSERDA, which commits DOE and NYSERDA to jointly prepare an EIS for WVDP completion and site closure, eliminating duplication of effort and thereby furthering progress on cleanup of the tanks and site.
- **Stipulation of Compromise Settlement between DOE and the Coalition on West Valley Nuclear Waste**, 1986. The result of this lawsuit says that waste cannot be removed from the site until the EIS (noted above) is completed.
- Completion of the EIS and issuance of a ROD for completion of the West Valley Demonstration Project by the US Department of Energy and closure of the Western New York Nuclear Service Center. The Draft EIS was made available to the public in March 1996. The EIS identifies and describes cleanup and closure alternatives for the site. Final cleanup and closure alternatives will be selected in the ROD for this EIS.

G.5.5 Milestones for WVDP

Selected West Valley Demonstration Project milestones are shown in Table G.6.

Table G.6. West Valley Demonstration Project Major Milestones

Milestone Title	Completion Date
Complete pretreatment operations	1995
Begin radioactive operation of waste vitrification facility	1996
Complete Phase I waste vitrification activities	1998
Waste tank heel removal complete	2001
HLW canister shipment	2036
Project completion	2041
Source: Planning Module: Integrated Planning, Accountability, and Budgeting System, March 2000.	

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Appendix H

Technical Reviews

Appendix H

Technical Reviews

OST has provided the Focus Areas with general guidance on planning and conducting technical reviews. TFA has developed a specific strategy for conducting a variety of technical reviews of new and ongoing projects that is consistent with the program's specific needs for monitoring technical progress and with OST guidelines. Technical reviews are an important element of the TFA review strategy. The overall goal of these reviews is to help ensure that TFA projects, and ultimately the overall program, deliver technical solutions that will successfully meet the needs of the user. Many of these reviews are independent in that they are conducted by experts that do not have a participating role or organizational interest in the activity undergoing review.

The key types of technical reviews conducted under the TFA Program include:

- Independent reviews
- Technical progress reviews
- Gate reviews
- Midyear reviews
- Proposal reviews
- Ad hoc or externally requested reviews

The TFA has a variety of technical expert groups at its disposal from which to draw upon on when planning reviews:

- Technical Advisory Group (TAG)
- Technology Integration Managers (TIMs)
- User Steering Group (USG)
- Technical Team
- American Society of Mechanical Engineers (ASME)

H.1 Independent Reviews

Independent reviews focus on technical feasibility/validity and relevancy in meeting the needs of users and the TFA. These reviews are typically conducted on "new starts" or projects in the early stages of the technology maturity cycle. Two types of independent technical reviews are conducted – ASME Peer Reviews as defined under OST guidelines, and reviews conducted by the TFA TAG. Reviews of proposals, new starts, and ongoing projects that meet certain requirements are performed by relevant experts selected by ASME. Projects nearing deployment where the end user will make decisions on technology acceptance and deployment are not considered for ASME Peer Review. Specific requirements and criteria for conducting these reviews are provided in procedures developed for OST by

the Institute for Regulatory Science.[a] ASME reviews and recommendations are documented in a formal report to the Focus Area Program Manager. TAG reviews are conducted on new starts and projects where ASME reviews do not apply. These reviews are then documented in a letter report to the TFA Program Manager.

H.2 Technical Progress Reviews

Technical progress reviews focus on technical feasibility/validity and assess the progress of the work according to the defined technical objectives. These reviews are typically conducted on ongoing projects that are approaching major decision points, such as decisions to proceed with major equipment investments or "hot operations"; for projects experiencing programmatic issues such as a loss of co-funding by the user; and for periodic assessment of activities in the mid to late stages of the technology maturity cycle. Technical progress reviews are performed by the TFA's TAG, TIMs, USG, Technical Team, or SMEs, depending on the stage of the project and complexity of the technical area under review. Often, a review team comprised of representatives from several of these technical expert groups is convened, depending on the objectives of the review. Results of these reviews are generally documented in a letter report provided to the TFA Program Manager (DOE-RL).

H.3 Gate Reviews

Gate reviews focus on the technology maturity stage of the project. This type of review is required in advance of a project's transition into certain gates - Gate 2 (Development) and Gate 5 (Demonstration). These reviews are conducted by a team comprised of representatives from TFA's Technical Team, TIMs, TAG, and users as appropriate. A gate review checklist is developed by the Technical Team and TIMs and used to facilitate and document the results of the review. A gate review report in letter report format, including the completed checklist, is provided to the TFA Program Manager.

H.4 Midyear Reviews

Midyear reviews focus on the progress or performance of ongoing projects. These reviews are conducted on each actively funded project to status the progress and performance of the project. These reviews are typically conducted by the TFA Technical Team, USG, and DOE Management Team around the midpoint of the fiscal year. Specific guidance provided by OST is used in planning for the midyear review and includes completion of project maturity checklists for ongoing projects. Additional business review of project deliverables and fiscal performance are also included in the midyear review process. Review of program planning, including review of multi-year technical responses for outyears is included in the midyear review process. The midyear review activity may span several months and include a composite of separate activities that are documented in a midyear review report.

(a) As described in the *Handbook of Peer Review, November 1999.*

H.5 Proposal Reviews

The key areas of focus in proposal reviews are on technical feasibility/validity and user and program relevancy. These technical reviews are generally conducted on proposals received in response to "calls" or requests for proposals generated by the TFA. Review teams comprised of representatives from the TAG, Technical Team, and TIMs are assembled. In addition, proposals meeting requirements for ASME reviews are reviewed by relevant experts from ASME. ASME reviews and their recommendations are documented in reports and considered in the proposal evaluations. Technical review recommendations are sent to the TFA Program Manager, who combines them with the DOE assessment of the business portion of the proposals and then makes the ultimate project selection.

H.6 Ad Hoc/Externally Requested Reviews

Because of its network of technical experts, the TFA is often requested by the sites (DOE Field Offices, DOE-HQ, and contractor organizations) to conduct technical reviews. The primary focus of these reviews is on providing an independent assessment. These reviews are typically conducted by review teams assembled by the TFA Technical Team and comprised of representatives from the various technical expert groups (i.e., TAG, TIMs, USG, etc.), and other broadly selected reviewers depending on the needs and objectives of the review. Examples of this type of review include the independent assessment by TFA for DOE-ID on selected technologies being considered under the EIS process for the treatment of liquid tank waste and calcine, and DOE-Fernald's recent request for an independent assessment of the final design documents for the retrieval systems for their Accelerated Waste Retrieval Project (AWR). Specific reporting formats and products of these reviews are negotiated with the requesting organization and include a range of documents such as letter reports or more detailed published technical reports.

H.7 Review Strategy and Process

The TFA's framework or strategy for planning, conducting, and documenting technical reviews is reflected in Table H.1. Each year, the TFA review process starts with an initial assessment of the review needs for existing and new projects. This initial assessment occurs at the technical response stage and is used to determine the overall review approach/strategy for the project, including the type of review(s) that will be needed. Reviews anticipated as a result of this initial assessment are highlighted in the technical response. After finalization of technical responses and during development of the PEG, a second, more detailed assessment is performed to determine the specific review(s) to be conducted in the coming year and the best timing for the review(s). Specifying the review(s) in the PEG helps ensure the review is planned and funded.

Once the reviews for all of the projects have been identified, a review schedule for the coming year is prepared by the TFA. This plan and schedule spells out, for each project/review, the proposed review schedule and logistics, review objectives and criteria, review team, and review materials and documentation. The schedule is then used to prepare and conduct the reviews.

Following each review, a review report is prepared. The report describes the review and outlines observations and recommendations. Responses to the recommendations are then prepared, distributed, and tracked to completion.

Table H.1. TFA Review Strategy

Review Drivers/ Requirements	Review Objectives	Review Timing/ Scheduling	Type of Review	Candidate Reviewers	Review Materials	Review Products/ Documentation
• New work - Newly Proposed Projects - Competing Proposals	• Technical Feasibility/Validity • User Need • Program Relevancy	• Technology Maturity Stages 0-4/5	• Independent Reviews	• ASME • TAG • Technical Team • TIMs • SMEs	• SOW • Review Criteria • MYTRs/PEGs/TTPs • Presentations • Request for Proposals • Proposals	• Review Reports
• Ongoing Projects with Major Decision Points or Major Technical or Performance Issues	• Technical Feasibility/Validity • User Need	• Various Technology Maturity Stages	• Technical Progress Reviews • Gate Reviews • Midyear Reviews	• TIMs • USGs • Technical Team • SMEs • TAG	• Performance Reports • Planning Documents	• Letter Reports • Meeting Minutes
• Ongoing Projects - Every Three Years	• Progress/Performance	• Various Technology Maturity Stages	• Gate Reviews • Midyear Reviews • Independent Reviews	• TIMs • TAG • USG • Technical Team • ASME	• Performance Reports • Technical Reports	• Review Reports • Gate Checklists • Midyear Checklists
• Ad hoc/Externally Requested Reviews	• Independent Assessment	• Various Technology Maturity Stages	• Various (Depends on Requirements)	• Technical Team • TAG • TIMs • SMEs	• Various (Depends on Requirements)	• Published Reports • Letter Reports

Appendix I

Glossary

Appendix I

Glossary

ablation	removal by cutting, abrading, or evaporating. Laser ablation refers to the use of a pulse laser beam to remove a very small amount from a tank waste sample.
alkaline	having a pH greater than seven. Bleach has a pH of about 12.5, ammonia has a pH of about 11.5. Tank waste generally falls into the pH range of 9-14, with the top of the range being an extremely basic solution.
alpha particle	a particle consisting of two neutrons and two protons, given off by the decay of many elements, including uranium and plutonium. Alpha particles cannot penetrate a piece of paper, so they are very easy to shield against. However, alpha-emitting isotopes inside the body can be very damaging.
annulus	the space that separates the two carbon steel walls of a double-shelled tank or the steel wall and outer containment/structural support. The annulus provides a margin of safety in the case of leaks from the primary containment, because the leak can be detected and waste removed before it might escape and enter the underlying soil.
aquifer	a permeable geologic formation that can hold and transmit large quantities of groundwater.
background radiation	radiation from natural radioactive materials always present in the environment, including radiation from the sun and outer space, and radioactive elements in the upper atmosphere, the ground, building materials, and the human body. Natural sources in the United States generate an average of about 300 millirem per year.
baseline	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 formally established, baselines are subject to change control procedures.
beta particle	a particle emitted in the radioactive decay of many radionuclides. A beta particle is identical to an electron. It has a short range in air and a low ability to penetrate other materials.
Bethel Valley Evaporator Service Tanks	these five tanks at the Oak Ridge Reservation have 50,000-gallon capacities and a similar configuration to the Melton Valley Storage Tanks. The tanks contain 60,000 gallons of supernate with 4,000 curies and 20,000 gallons of sludge with 8,000 curies. This is newly generated waste.

calcination	this process converts liquid, high-level radioactive waste to a solid using a drying process with a high temperature fluidized bed. Calcination achieves a 7-to-1 volume reduction and can be stored up to 500 years. At Idaho National Engineering and Environmental Laboratory, 1 million gallons of calcine containing 50 million curies is currently stored in 7 vaults.
calcine	a dry, granular waste form with the consistency of laundry detergent. Calcine is created by the process of calcination and stored in vaults at Idaho National Engineering and Environmental Laboratory, near Idaho Falls, Idaho.
canister	the outermost container, generally made of stainless steel or an inert alloy, into which vitrified high-level waste or spent fuel rods are placed.
Class A Low-Level Waste	defined by the U.S. Nuclear Regulatory Commission. To be categorized as Class A Low-Level Waste, the final waste form must contain less than 10 nanocuries per gram of alpha-emitting transuranic elements with half-lives greater than 5 years, less than 0.04 curies per cubic meter of strontium-90, and less than 1.0 curie per cubic meter of cesium-137.
closure	long-term stabilization of underground storage tanks
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	(often called the Superfund); the 1980 federal statute that provides for the compensation, liability, cleanup, and emergency response for hazardous substances released into the environment and for the cleanup of inactive waste disposal sites. CERCLA was amended in 1986 and applied to waste sites owned by the federal government.
contamination	radioactive or hazardous chemical materials where they are unwanted or in a concentration that threatens human or environmental health.
corrosion coupon	in reference to a waste storage tank: a piece of metal, of like material to that of a tank, that is inserted into the tank waste and left there for a period of time. Once pulled from the tank it is evaluated for corrosion. The presumption is that the tank material (walls, dome, etc.) will perform just as the “coupon” does.
Corporate Review Budget (CRB)	the budget developed for the fiscal year +2. For example in April 2000, the TFA will develop its budget for FY2002. CRB is synonymous with IRB (Internal Review Budget).
critical mass	the mass of radioactive material that is enough to begin a nuclear chain reaction. For plutonium-239 and uranium-235 metals, this is about 25 and 110 pounds, respectively. Under certain conditions, as little as 1 pound of plutonium can form a critical mass.
crosscutting program	a program that manages common technology needs across the sites.

curie	a basic unit used to describe the intensity (strength) of radioactivity in a material. A curie is a measure of the rate at which a radioactive material gives off particles and disintegrates. It is also the amount of radioactivity in 1 gram of the isotope radium-226. One curie gives off 37 billion disintegrations per second. A typical home smoke detector contains about 1 millionth of a curie of radioactivity.
cyclotron	a circular particle accelerator in which charged subatomic particles generated at a central source are accelerated spirally outward in a plane perpendicular to a fixed magnetic field by an alternating electric field.
defense waste	radioactive waste resulting from weapons research and development, the operation of naval reactors, the production of weapons material such as plutonium, the processing of defense spent fuel, and the decommissioning of nuclear-powered ships and submarines.
Defense Waste Processing Facility	a high-level waste vitrification plant built at the Savannah River Site. The plant began vitrifying waste in 1996. At this plant, the waste is vitrified and then poured into stainless steel canisters. These 3,700-pound filled canisters are currently being stored at the Site, but eventually will be transported to a geologic repository. As of October 1996, the plant had been running for 6 to 8 months and produced 72 canisters of high-level waste glass.
disposal	removal of contamination or contaminated material from the human environment, although with provisions for monitoring, control, and maintenance.
dose	a quantity of radiation or energy absorbed; measured in rads or rem.
double-shell tank	a reinforced concrete underground vessel with two inner carbon steel liners. Instruments are placed in the space between the two liners (called the annulus) to detect liquid leaks from the inner liner.
effective dose equivalent	an estimate of the total risk of potential health effects from radiation exposure.
effluent	a discharge of liquid waste, as from a factory or nuclear plant.
exposure	being present in an energy field such as sunlight or other external radiation; or touching or ingesting a hazardous agent.
feed	the waste stream that enters a vitrification plant and is combined with glass formers to produce an immobilized waste product.
fiscal year	refers to the Department of Energy's fiscal year, which runs from October through September. The fiscal year is named for the latest year in the period. For example, fiscal year 1999 (FY99) runs from October 1998 to September 1999.

fission	the process in which a uranium atom absorbs a neutron and then splits into two smaller atoms, releasing a relatively large amount of energy and one or two neutrons. Then, these neutrons can cause other uranium atoms to undergo fission, releasing more energy and still more neutrons. Eventually, a nuclear reaction is achieved in which only one neutron from each uranium atom that undergoes fission causes another uranium atom to fission. This is a nuclear chain reaction. Fission products are the smaller atoms produced by the splitting of the uranium atoms.
Gunite and Associated Tanks (GAAT)	located at the Oak Ridge Reservation, the 16 GAATs have capacities ranging from 1,500 to 170,000 gallons. Eight of the tanks are 170,000-gallon vertical concrete-rebar tanks built in 1943 and 1944 to support the Manhattan Project. In the early 1980s, 90 percent of the alkaline sludges were sluiced from the tanks and sent to the hydrofracture operation for disposal. Only 10 percent of the activity remains. The tanks currently hold sludge heels (containing 345,000 gallons of supernate with 4,000 curies) and 49,000 gallons of sludge with 14,000 curies. The supernate is considered mixed low-level waste. The sludges are considered mixed, low-level, and transuranic waste. For more information, see the Oak Ridge Reservation website.
gunite process	a concrete-rebar construction process where cement, sand, and water are mixed together and then sprayed over a steel reinforcing framework. This process, which is similar to the process used to create swimming pools, was used to build some of the tanks at the Oak Ridge Reservation in Tennessee.
half-life	refers to the amount of time needed for a radioactive material to lose 50 percent of its radioactivity by decay. Half-lives range from less than one second to billions of years.
Hanford Site	a 560-square-mile Federal government-owned reservation located in the desert of southeastern Washington State. It was established in 1943 as part of the Manhattan Project. Its primary mission was to produce plutonium for nuclear weapons. Hanford contains nine production reactors, four chemical separation plants, and 177 underground tanks.
hazardous waste	nonradioactive waste such as metals (lead, mercury) and other compounds that pose a risk to the environment and human health.
heel	residual solid waste at the bottom of a tank
high-level waste (HLW)	waste from the reprocessing (chemical separation) of uranium and plutonium from other nondesired radioactive elements. High-level waste contains most of the radioactive elements discharged as waste to the underground tanks.

hot cell	an enclosed area and its associated equipment that provides shielding, containment, and remote handling capabilities for work involving radioactive materials, such as tank waste samples.
in situ	in place.
incidental waste	a concept originated by the Atomic Energy Commission - and subsequently used by the Nuclear Regulatory Commission and the Department of Energy - to separate high-level waste from the low-activity fraction generated during further treatment of high-level waste. Incidental waste is defined by both origin and characteristics; if the low-activity fraction of high-level waste has the characteristics of low-level waste (see definition of low-level waste), the low-activity fraction may be classified as incidental waste.
Idaho National Engineering and Environ-mental Laboratory	an approximately 890-square-mile Federal government-owned reservation located in the eastern Idaho desert. The laboratory is the site of 52 reactors. Some of these reactors were prototypes for special-purpose reactors, some were materials-test reactors, and some were designed to test safety concepts and accident conditions. Today, only the Advanced Test Reactor is currently operating.
isotopes	different forms of the same chemical element distinguished by different numbers of neutrons in the nucleus. A single element may have many isotopes; for example, there are 14 isotopes of americium. Some isotopes may be radioactive; others may not be radioactive.
leverage	to formally link budget and scope across performing organizations to gain the greatest benefit. The TFA works to leverage DOE investments in tank-related science and technology activities.
low-level waste (LLW)	a catch-all category for any radioactive waste that is not spent fuel, high-level, or containing large amounts of transuranic (e.g., plutonium) waste. It can include liquid waste or contaminated clothing, tools, and equipment. [See also, Class A Low-Level Waste]
Manhattan Project	the U.S. Government project that produced the first nuclear weapons during World War II. The Hanford Site, the Oak Ridge Reservation, and the Los Alamos National Laboratory were created for this effort.
Melton Valley Capacity Increase Tanks	six new stainless steel tanks built in the Melton Valley area at Oak Ridge Reservation. While similar in design to the original Melton Valley Storage Tanks, these tanks have larger, 100,000-gallon capacities. These tanks went on line in December 1998.

Melton Valley Storage Tanks	eight 50,000-gallon horizontal stainless steel tanks at the Oak Ridge Reservation. The Melton Valley Tanks have a primary shell that holds the waste and a secondary shell that stops leaked waste before it can reach the environment. The tanks contain 200,000 gallons of supernate with 20,000 curies and 100,000 gallons of sludge with 100,000 curies. The source for this waste is residuals from gunite tanks and newly generated waste from reactors and decontamination and decommissioning operations. The supernates are classified as mixed low-level waste. The sludges are mixed transuranic waste.
mixed waste	waste that contains both radioactive and hazardous waste components.
multiyear program plan (MYPP)	a document that includes high-level descriptions of planned scope, schedule, and budget for several years. The MYPP defines the TFA technical program and provides the basis for requests for proposals. The MYPP is reviewed at least annually to determine if changes are necessary.
Oak Ridge Reservation	a 58-square-mile Federal government-owned reservation located near Knoxville, Tennessee. The site was established in 1943 to produce enriched uranium. The Tanks Focus Area is focused on four sets of tanks: inactive Gunite and Associated Tanks, inactive Old Hydrofracture Facility Tanks, active Bethel Valley Evaporator Service Tanks, and active Melton Valley Storage Tanks. Combined, the tanks contain 648,000 gallons of supernate with 31,300 curies, and 177,000 gallons of sludge with 154,500 curies.
Old Hydrofracture Tanks	five horizontal carbon steel tanks at the Oak Ridge Reservation. They have capacities ranging from 13,000 to 25,000 gallons. The tanks contain 37,000 gallons of supernate and 6,100 gallons of sludge.
paths to closure	a Department of Energy term referring to the schedule, activities, and costs for completing the government's environmental cleanup mission.
plutonium	a manmade element capable of being split by a low-energy neutron. Plutonium-239, which is used to make nuclear weapons, has a half-life of 24,000 years.
pneumatic	the use of compressed air
portfolio	a grouping of investments that maximizes returns while minimizing risk.
pretreatment	chemical or physical treatment process or a series of processes used to prepare waste for immobilization.
privatization	a contractual agreement between a governmental entity and a private company to provide goods or services for a negotiated fee using privately developed, financed, constructed, owned, operated and deactivated facilities.

rad	acronym for radiation absorbed dose; a unit that measures the amount, or dose, or radiation absorbed by any material, such as human tissue. Rad is the amount of radiation absorbed, rem is the potential damage done to a human from that absorption.
radiation	particles or energy waves emitted from an unstable element or nuclear reaction.
radioactivity	the property possessed by some isotopes of elements of emitting radiation (alpha, beta, or gamma rays) spontaneously in their decay process.
radionuclide	a radioactive atomic species or isotopes of an element.
rem	an acronym for roentgen equivalent man; a unit of radiation dose that indicates the potential for impact on human cells. "Quality factors" (such as 10 for beta particles and 20 for alpha particles) are given to the different kinds of radiation to convert rad to rem.
remediate	to correct a fault or deficiency; commonly referred to as "cleanup" when referring to the nation's nuclear waste.
reprecipitation	the separation of solids from a solution following previous (or earlier) dissolution processes.
reprocessing	the process by which fuel that has been used in a reactor (spent fuel) is separated into useful materials such as uranium and plutonium and waste products.
Resource Conservation and Recovery Act of 1976 (RCRA)	the federal law that regulates the management of hazardous waste, including the hazardous component of radioactive mixed waste, at operating facilities. With respect to the U.S. Department of Energy site cleanup, RCRA is concerned with the assessment and cleanup of waste sites and sites associated with operating facilities.
rheology	the study of the deformation and flow of matter.
riser	a pipe, varying in diameter, that connects the tank to the surface. The number of risers, their availability (some are used for equipment such as thermocouple trees), and location are key issues in sampling and retrieving waste.
saltcake	the crystalline water-soluble solids in waste tanks.

Savannah River Site	the approximately 300-square-mile Federal government-owned reservation located near Aiken, South Carolina. (DOE, 1995, Closing the Circle, pg 98) The Site's primary missions were to produce tritium and plutonium-239 for atomic weapons, plutonium-238 to support the space program, and special nuclear materials to support medical programs. In 1991,production of nuclear materials for weapons use stopped at the site. However, spent nuclear fuel reprocessing facilities are still operated to supply uranium to the National Aeronautics and Space Administration. The site contains five heavy-water-moderated reactors, a heavy-water production plant, facilities for making fuels and targets, a research laboratory, and two chemical extraction areas.
single-shell tank	an older style of underground tank that has a single carbon-steel liner surrounded by reinforced concrete. The domes of these tanks are made of concrete without an inner covering of steel.
sludge	a thick layer containing chemicals that have precipitated or settled to the bottom of a tank. Sludge can be difficult to pump.
sorbents	chemicals that act as a "sponge" to capture unwanted elements from a waste stream during pretreatment processes. Sorbents eventually lose their binding ability and must be replaced.
spent fuel	fuel that has been "burned" (irradiated) in a nuclear power plant's reactor to the point where it no longer contributes efficiently to the nuclear chain reaction. Spent fuel is thermally hot and highly radioactive.
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.
stage-gate	refers to the Department of Energy's six-step process for reviewing and evaluating the development of a technology, from basic research through deployment.
Superfund	a nickname for the Comprehensive Environmental Response, Compensation, and Liability Act of 1980; the federal statute that provides for the compensation, liability, cleanup, and emergency response for hazardous substances released into the environment and for the cleanup of inactive waste disposal sites. CERCLA was amended in 1986 and applied to waste sites owned by the federal government.
supernate	the upper layer of salts in a waste tank dissolved in water.
transuranic element	elements, such and plutonium and neptunium, that have atomic numbers (number of protons in the nucleus) greater than 92. All are radioactive.

transuranic waste	waste contaminated with alpha-emitting elements that have atomic numbers (number of protons in the nucleus) greater than 92 with half-lives greater than 20 years in concentrations of more than 1 ten-millionth of a curie per gram (0.03 ounce) of waste.
U.S. Nuclear Regulatory Commission	an independent federal agency established in 1974 to develop and enforce regulations regarding civilian nuclear activities, such as power plants. The NRC has developed regulations for high-level and low-level waste disposal and is responsible for licensing nuclear waste facilities, including the high-level waste repository.
users	staff and organizations located at the five waste tank sites responsible for managing the wastes.
uranium-235	the lighter of the two main isotopes of uranium. Of the uranium that is mined from the earth, 0.7 percent of it is uranium-235. It has a half-life of 714 million years and is the only naturally occurring element capable of being split by a low-energy neutron. Uranium-235 is used in the production of plutonium-239.
vadose zone	a geological zone that encompasses the soil from the ground surface to, but not including, the groundwater; often used in reference to the soil around a tank or tank farm.
vitrification	a process that combines concentrated radioactive waste (mostly cesium and strontium) and glass-forming materials. The melted glass-waste mixture is poured into metal canisters, where it hardens into logs. Vitrification plants have been built in the United Sates at West Valley, New York, and the Savannah River Site in South Carolina.
waste	in this context, unwanted materials left over from the production of nuclear materials. This type of waste has been disposed of in numerous ways, such as dumping it to the soil, into rivers, into aboveground or below ground tanks, and/or burying it in boxes or drums.
waste management	the treatment, storage, and disposal of radioactive waste, hazardous waste, mixed waste, and sanitary waste.
Watch List	a list of tanks published in Public Law 101-510, Section 3137 (also known as the Wyden Bill). The law requires DOE to treat listed tanks in such a way as to avoid any potential releases of materials to the environment.
water table	the upper surface in an aquifer where the pore spaces in the geologic formation are filled with water that moves down a hydraulic gradient.
weapons-grade uranium	uranium that contains over 90 percent uranium-235.

West Valley Demonstration Project (WVDP)	a 200-acre site located near West Valley, New York. The WVDP began operations in 1966 as a demonstration facility for reprocessing commercial spent fuel to recover uranium and plutonium. From 1966 to 1972 the facility produced 550,000 gallons of highly radioactive waste before the site operator, Nuclear Fuel Services, Inc., halted operations to evaluate the facility's expansion potential. In 1980, the WVDP Act was signed, directing the U.S. DOE to solidify and develop suitable containers for the site's high-level radioactive waste; transport the solidified waste to a federal repository; and dispose of the low-level radioactive and transuranic wastes created during project operations. West Valley Nuclear Services Co., Inc., was awarded the operations contract and has been the primary contractor ever since.