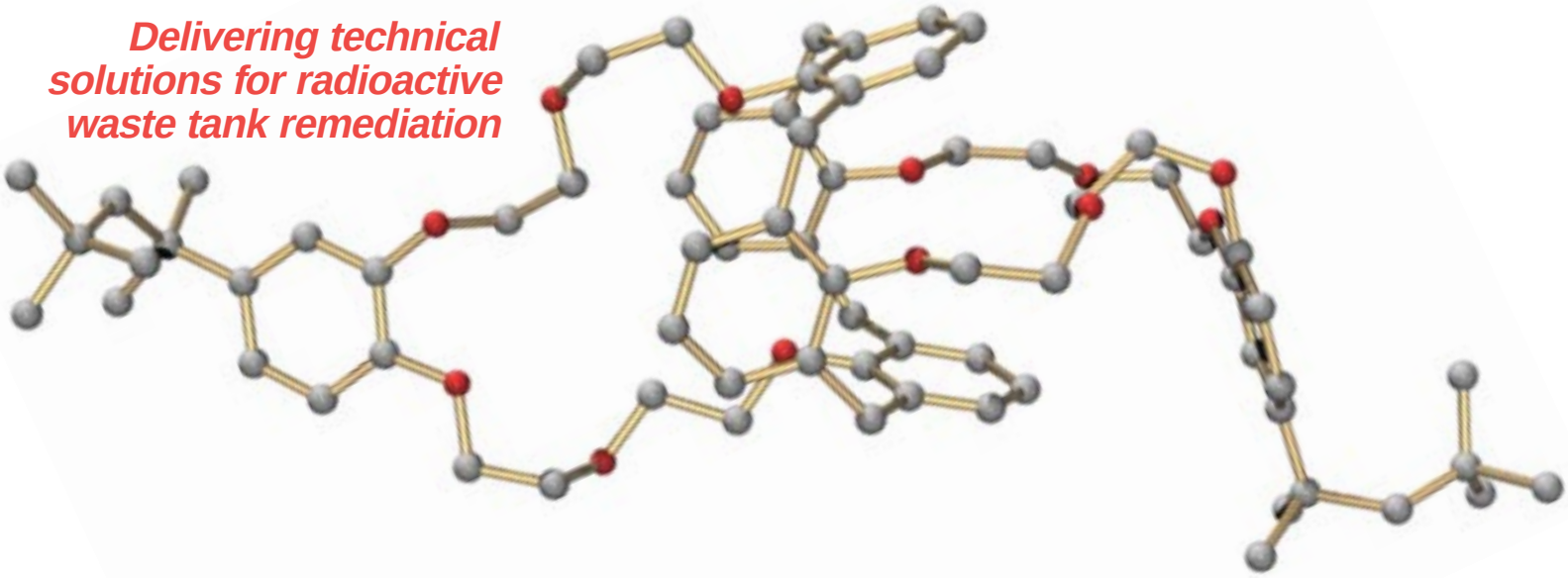
Tanks Focus Area

Delivering technical solutions for radioactive waste tank remediation



FY2001 Annual Report

U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

Contents

Page

1 Program Message

2 Background

3 Vision, Mission, and Goals

4 Process Steps

6 Management and Organization

8 Fiscal Year 2001 Accomplishments
- 8 Hanford Site
- 11 West Valley Demonstration Project
- 12 Idaho National Engineering and Environmental Laboratory
- 14 Oak Ridge Reservation
- 16 Savannah River Site

18 Innovative Technology Summary Reports

19 Fiscal Year 2001 Project Summary

Front cover: Calixarene molecule used to strip cesium from waste streams in the Caustic-Side Solvent Extraction separation process at the Savannah River Site.

Back cover: Double salt (Na_3FSO_4) from Hanford Tank BY-102 as seen through a polarized light microscope.

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

November 15, 2001

Subject: Tanks Focus Area Program Message

On behalf of all those involved in the Tanks Focus Area (TFA) program, we are pleased to report that fiscal year (FY) 2001 marked another successful year in application of science and technology to support the U.S. Department of Energy (DOE) tank cleanup program. Development and delivery of technical solutions that respond to science and technology needs identified by users from across the complex remains the primary force and direction behind TFA.

In FY 2001, 14 deployments of innovative technical solutions were directly applied to real waste cleanup application at 5 sites. Furthermore, there were demonstrations of 16 technologies that show promise as being ready for implementation. These accomplishments add to the ongoing list of 224 technical solutions, accounting for approximately 160 deployments and data deliveries, since the program's inception in 1994. The application of TFA technical solutions has accounted for more than $250 million in cost savings (or avoidance) with a projected life-cycle savings of over $5 billion.

TFA continues to enable tank cleanup through sound scientific research, new and innovative technologies, and top-class technical expertise.

- **Scientific Research**—TFA provides critical research and analysis to support site cleanup operations. Examples include glass formulations in support of efficient melter operations at Hanford, Idaho, and Savannah River; waste rheology measurement in support of characterization and prevention of pipeline plugging at all sites; and investigation of saltcake chemistry to support waste retrieval and processing operations at Hanford and Savannah River.

- **Innovative Technologies**—TFA develops and supports deployment of innovative technologies to enable tank cleanup, improve upon existing technologies, and provide safer and more efficient operations. Examples include demonstrations of the Pit Viper and Topographic Mapping System at Hanford and deployments of the Pulsating Mixer Pump at Oak Ridge and the Burnishing Sampler at West Valley.

- **Technical Expertise**—TFA provides high-quality technical expertise to validate and recommend improvements to current operations, aid in site decisions, and solve critical operating issues at the sites. Examples include the High-Level Waste Melter Study for Hanford, Idaho National Engineering and Environmental Laboratory Roadmap Validation, Hanford Interim Stabilization Workshop, and management of the Savannah River Site Salt Processing Project research and development activities.

The reduction of cost, schedule, and risk is more important now than ever for the tank cleanup program. Technical solutions that address both near-term and longer-term strategic needs are critical in reducing the billions of dollars in out-year costs. TFA remains committed to working closely with cleanup program managers to provide the best technical solutions possible and to ensure that DOE science and technology funding is directed to achieve the greatest impact possible on the tank cleanup program.

Thank you for your continued support and contributions to the success of TFA!

Ted Pietrok

Ted Pietrok, Program Lead
Tanks Focus Area

The Tanks Focus Area Works with Users to Implement Technical Solutions to Sites' Needs

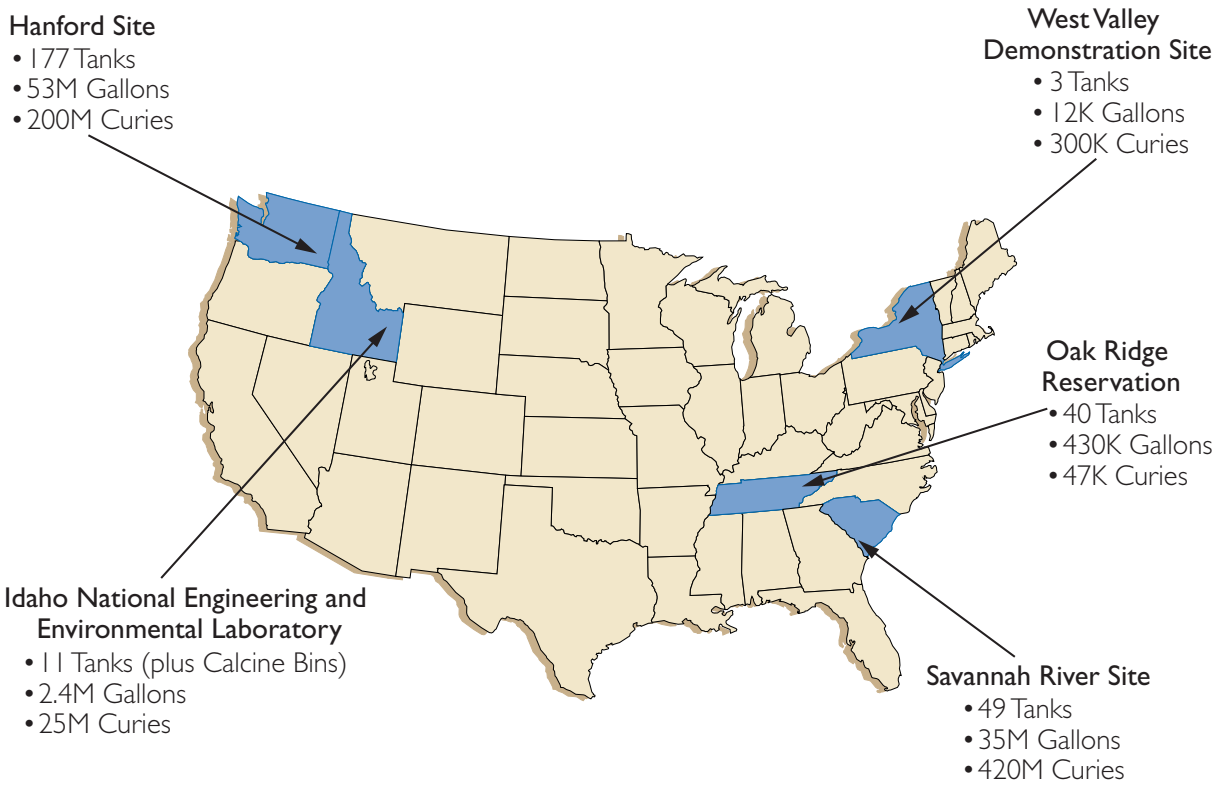
Technical solutions working to enable tank cleanup

The U.S. Department of Energy (DOE) continues to face a major radioactive waste tank remediation effort with tanks containing hazardous and radioactive waste resulting from the production of nuclear materials. With some 90 million gallons of waste in the form of solid, sludge, and liquid stored in 280 tanks across the DOE complex, containing approximately 650 million curies, radioactive waste storage tank remediation is the nation's highest cleanup priority.

Differing waste types and unique technical issues require specialized science and technology to achieve tank cleanup in an environmentally acceptable manner. Some of the waste has been stored for over 50 years in tanks that have exceeded their design lives. The challenge is to characterize and maintain these contents in a safe condition and continue to remediate and close each tank to minimize the risks of waste migration and exposure to workers, the public, and the environment.

In 1994, the DOE's Office of Environmental Management (EM) created a group of integrated, multiorganizational teams focusing on specific areas of the EM cleanup mission. These teams have evolved into five focus areas managed within EM's Office of Science and Technology (OST):

- **Tanks Focus Area (TFA)**
- Deactivation and Decommissioning Focus Area
- Nuclear Materials Focus Area
- Subsurface Contaminants Focus Area
- Transuranic and Mixed Waste Focus Area



The Tanks Focus Area Vision—Enable Tank Cleanup at DOE Sites

The **TFA Mission** is to work with users to develop, deliver, and implement technical solutions through an integrated approach to safely and efficiently accomplish tank waste remediation at five major DOE tank sites.

The Tanks Focus Area

- brings together the sites' users, technical experts, and efficient management concepts to execute the mission;
- integrates efforts across the sites and utilizes multiple funding organizations; and
- builds teams of users and providers to deliver and deploy technical solutions.

To accomplish this mission, **TFA Goals** include working to increase OST's funded results, reduce programmatic and technical risk, and pursue contingency or alternative technology approaches.

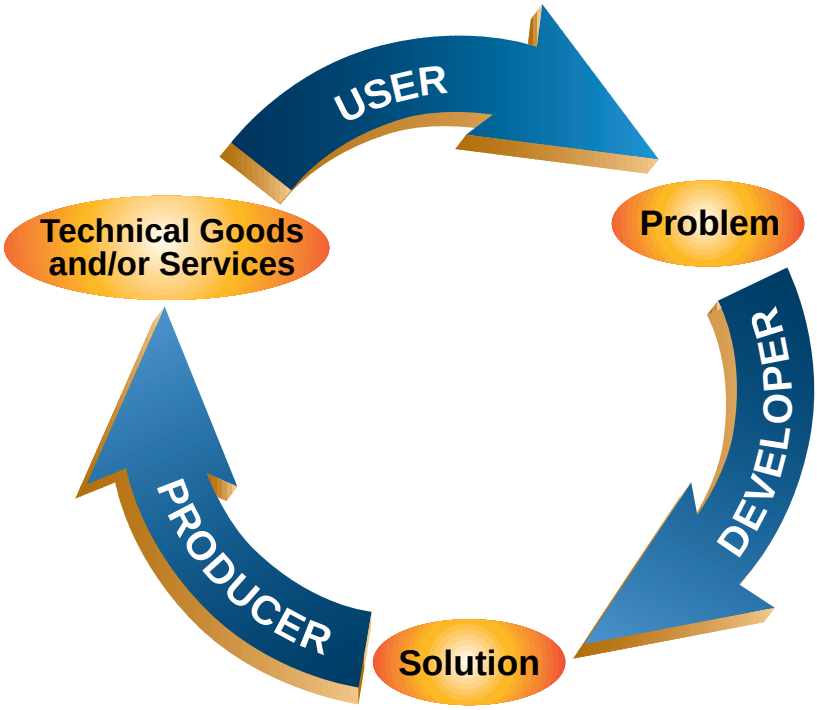
Pursuant to the mission and these goals, TFA seeks to:

- **integrate** technical solutions into cleanup efforts;
- create plans to address EM's **toughest problems**, help sites reduce **technical risk**, and meet **compliance** agreements;
- develop technologies for **deployment** at multiple sites as the new **baseline** approach to cleanup;
- reduce **environmental risk** through comprehensive technical solutions;
- provide technical expertise and technologies that enhance **worker safety**;
- reduce **cost** and accelerate cleanup **schedules**; and
- provide **benefits outside the EM program** by providing innovative technical solutions to other agencies and organizations.

> "It is now more critical than ever to provide science and technology solutions that can reduce schedule and risk and minimize the significant out-year costs associated with the tank cleanup program."
>
> *Ted Pietrok,*
> *Tanks Focus Area Program Lead*

The TFA mission and goals directly support the Key EM Goals and Priorities, in particular the desire to:

- improve safety performance,
- significantly reduce cleanup costs,
- deliver technical solutions to minimize the need to treat the entire tanks waste inventory, and
- accelerate cleanup and closure.



Technical Solutions Are Categorized into Key Process Steps

Tank remediation follows five key process steps described below. **Characterization** and **monitoring** are critical and integral throughout each process step.

Safe Waste Storage—TFA supports site efforts to resolve technical issues associated with safe waste storage. Each site requires improvements in monitoring tank integrity, preventing tank corrosion, ventilating tanks, and characterizing tank waste. Waste minimization technologies are also being implemented to reduce the volume of waste being added to the tanks. TFA is investing in tools to more effectively monitor the conditions of the tanks and more cost-effectively maintain safe tank conditions.

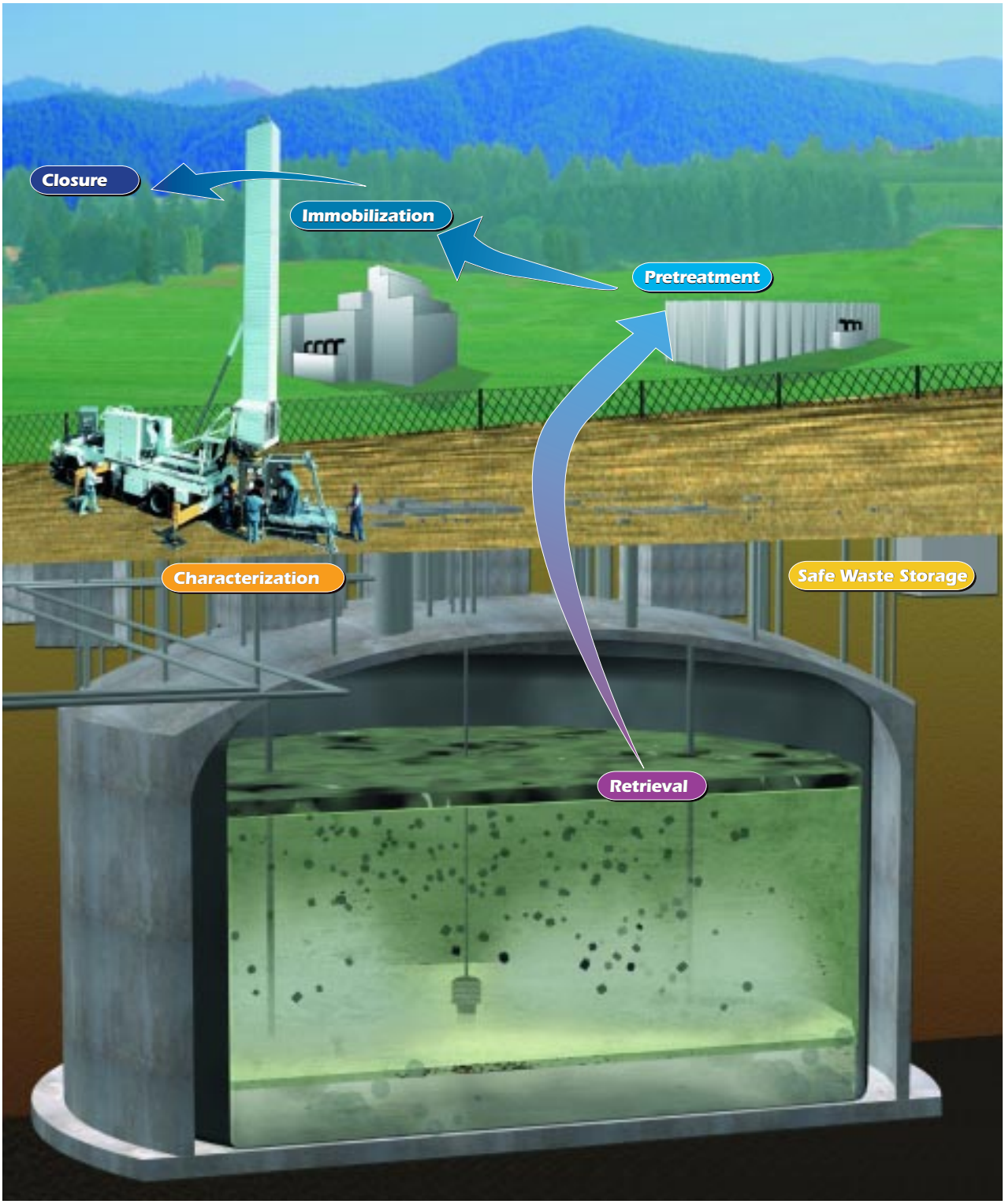
Retrieval—Before closure, most radioactive waste tanks require waste retrieval, which must be accomplished with minimal impact on other tank cleanup activities and downstream waste processing. Waste types include solid, sludge, liquid, gas, and miscellaneous debris, each type and combination presenting unique challenges. Retrieval requires remotely controlled operations with tools able to enter underground tanks through small openings. Retrieval processes must also avoid causing waste to congeal or solidify, resulting in plugged transfer pipes. Characterizing and monitoring waste chemical and physical properties help prevent unwanted solids formation during retrieval and transfer. TFA is developing methods to mobilize hard, solid waste at tank bottoms ("heels"), while minimizing water additions to enable optimal transfer and treatment properties.

Closure—Closure of tanks is important for reducing costs and accelerating cleanup while minimizing the potential for release of wastes to the environment. The current baseline practice for closing tanks is to fill them with a grout formulation to immobilize tank waste residues. Technical solutions are being used to stabilize residual waste and provide structural integrity and isolation for emptied tanks. The TFA is developing closure solutions that will provide assistance in negotiating closure criteria within regulatory constraints, such as characterizing the final disposition of tanks and immobilized waste forms.

Pretreatment—Once retrieved, waste must be immobilized into a stable waste form. However, directly immobilizing all retrieved waste without pretreatment steps would be unnecessarily expensive and exceed planned storage space. Radionuclide separations are critical to isolating low- and high-activity fractions, as well as to removing problem constituents that impact downstream processing operations. Therefore, TFA is developing technical solutions to separate waste types and reduce high-level waste (HLW) volumes. Additionally, innovations in process monitoring techniques will improve operations of pretreatment systems.

Immobilization—Sites need to immobilize their waste into stable forms to prevent release of radioactivity or hazardous chemicals to the environment. The highly radioactive waste is typically melted into a durable, vitrified (glasslike) form. The less hazardous fraction of radioactive waste is

immobilized through vitrification or grouting. TFA continues to provide technical solutions to DOE to enhance glass and grout formulations and improve melter and waste product performance. Process and performance monitoring methods are also being evaluated to improve immobilization operations.



TFA is User Driven and Needs Based when Leveraging Resources to Deliver Technical Solutions

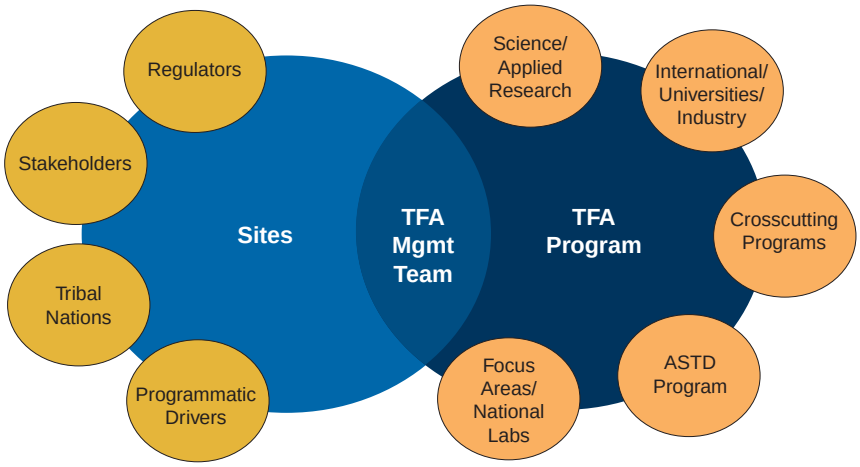
Site **needs** are the primary basis for the TFA technology development program. Annually, each of the DOE sites provides science and technology needs to TFA, identifying the areas in which the users require technical solutions to reduce uncertainty, risk, cost, and schedule in their cleanup programs. TFA then works actively with the sites through its network of Technology Integration Managers to understand the problems to be solved, the required performance specifications, the timing of the technical solutions, and their integration with other functions.

TFA **leverages resources**, such as funding and technical expertise, to solve the problems identified in the needs. These leveraging opportunities enable TFA to maximize the technical strength of the program and make the most efficient use of funding by solving common needs at multiple sites.

Technical solutions are derived from experts engaged in research and development such as academia, industry, and national laboratories. Technical solutions developed by TFA are delivered in three forms to enhance sites' baseline cleanup operations:

- **Scientific research**—strategic investments in basic science and applied research that can mature into a deployable technology or data that is important in decision-making processes
- **Innovative technologies**—development and support in deployment of innovative technologies to enable tank cleanup, improve upon existing technologies, and provide safer and more cost-effective solutions
- **Technical expertise**—providing technical experts to evaluate and recommend improvements to current operations, aid in site decisions, and solve critical operating issues

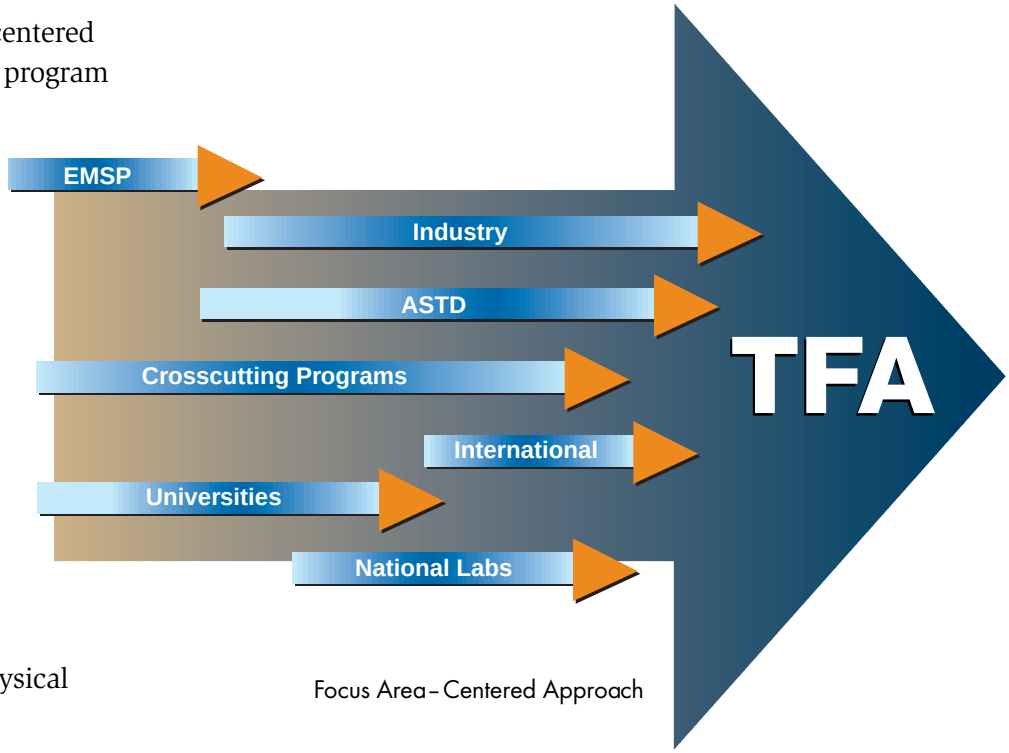
To ensure that technical solutions are **user driven**, TFA uses a management team approach to meet sites' highest-priority needs and address both near- and long-term issues. The TFA Management Team comprises DOE representatives from each site and the appropriate DOE Headquarters offices. Additionally, TFA consults with a User Steering Group, which consists of senior-level managers from contractors at tank waste sites who advocate the TFA program.



TFA integrates programs and other resources to meet the needs of sites.

Partnership Programs Support the Focus Area–Centered Approach

TFA implements OST's focus area–centered approach by fully integrating OST's program components. Through its integration role, the TFA and its partners strive to ensure planned and ongoing science and technology development work supports the users' needs without duplication.



Focus Area–Centered Approach

Crosscutting Programs–The OST focus areas share three common science and technology disciplines:

- **Efficient Separations and Processing** enables segregation of waste by distinct chemical and physical properties.
- **Robotics** utilizes remotely operated machines to characterize and handle wastes, preventing unnecessary human and environmental exposure.
- **Characterization, Monitoring, and Sensor Technology** develops enabling tools for identifying and analyzing waste constituents throughout all aspects of the cleanup process.

Industry Programs–Through DOE's National Energy Technology Laboratory, private-sector companies work cooperatively with TFA in developing technical solutions for deployment at DOE sites.

University Programs–Coordinates research and development of technologies that foster relations between universities and industry for advancement of science and engineering capabilities.

International Programs–Augments DOE's investments in science and technology by providing solutions based on waste remediation lessons learned from other nations.

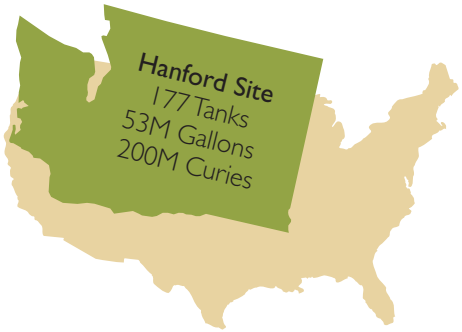
Environmental Management Science Program (EMSP)–Focuses on core scientific research that supports environmental decisions, technical risk reduction, and advanced technologies.

Accelerated Site Technology Deployment–Facilitates the implementation of proven technical solutions across the DOE complex.

Fiscal Year 2001 TFA Accomplishments

- **14** Deployments in radioactive tank waste remediation environments
- **16** Demonstrations to support future deployment actions
- **5** Technical Assistance Review responses addressing unique site issues

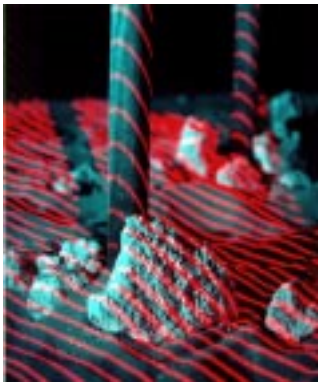
The following pages highlight several key technical solutions delivered by TFA during FY 2001. Technologies are identified by their Tech IDs in OST's Technology Management System (TMS), a database providing access to information relevant to EM programs, technical solutions, cleanup problems, and sites. Viewable at http://tms.em.doe.gov, TMS catalogs project details of approximately 220 HLW technical solutions from TFA and its partner programs. Reports on specific TFA accomplishments can be viewed and downloaded from http://www.tanks.org.



Tank Characterization with the Topographical Mapping System

(Tech ID 130)

Before aging radioactive waste storage tanks can be closed, the interiors of these tanks must be inspected to characterize and retrieve the remaining waste. Access is difficult because the tanks are buried several feet underground and riser openings are typically less than 2 feet in diameter. The only way to clearly view the waste, in-tank equipment, and other obstructions is to deploy a camera or imaging tool down the riser of the tank.



The Topographical Mapping System creates maps of waste topography and tank structures to recreate a computer model of the tank environment. The system can also be used to determine residual tank waste volume.

The Topographical Mapping System was developed in cooperation with TFA to support tank closure at the Oak Ridge Reservation. As the only available mapping technology capable of operating through a tank riser, it was deployed in 1997 to gather and analyze topographical data on obstacles and waste surfaces, generating a three-dimensional computer map of the data.

In support of fulfilling the Tri-Party Agreement at the Hanford Site, testing of the Topographical Mapping System demonstrated 92–99% accuracy in performing volumetric measurements. The River Protection Project installed the system in Tank U-107 at the Hanford Site to support the saltcake dissolution proof-of-concept demonstration. It will be used to measure the waste surface profile and estimate the volume before and after a test of the effectiveness of a waste retrieval technique using a low-water addition sprinkler followed by saltwell pumping. Data from this initial testing and retrieval system performance will be used to support planning for a retrieval deployment in FY 2002 to help fulfill a regulatory compliance milestone.

Pit Viper Demonstrates Safety and Savings—Coiled for Deployment

(Tech ID 2195, 2180)

Equipment pits located near underground tanks are critical to high-level waste storage and transfer operations. Baseline procedures used in valve pit operations are time-consuming and labor-intensive. Pit surfaces and equipment such as valves and pumps are contaminated from decades of routine tank farm operations and are one of the most radiation-intensive and hazardous work zones at Hanford. Pit operations and maintenance activities were identified as major contributors to dose received by tank farm operators at Hanford. Radiation levels, in some cases as high as 50 rads per hour, severely limit routine pit operations and the amount of time workers can be exposed to these conditions. In conjunction with site users, TFA developed the Remote Pit Operations Enhancement System, or "Pit Viper," a robotic system for performing remote pit cleanup operations for the Office of River Protection. This system will enable many currently manual operations to be performed remotely, thereby significantly reducing worker exposure.

The system's main components include a conventional backhoe with minor modifications for tank farm access and gross positioning, a robotic manipulator arm for positioning and operating tools in the pits. The system also includes the Compact Remote Operator Console located in a trailer from which the operators observe the work area and control the robotic equipment. In FY 2001, the system was demonstrated in a simulated valve enclosure pit at Hanford's Hazardous Material Management and Emergency Response test facility and subsequently provided training to Hanford tank farm personnel.

The Pit Viper demonstrated a full range of capabilities in grasping commercially available tools, such as cutting, grinding, and cleaning tools. The addition of a simple grab handle compatible with the manipulator gripper enables these tools to be deployed into the pit for remote operations. The manipulator gripper can also be used to lift and reposition objects or remove debris from the pits. Deployment of the system in FY 2002 is expected to significantly reduce personnel exposures, decrease pit operation and maintenance costs, and improve the availability of the pits to support tank waste retrieval and transfer schedules.

The Pit Viper, a robotic arm mounted on a backhoe, can perform a wide variety of hazardous and dose-intensive tasks. Once positioned, it is remotely controlled from the safety of an operations trailer.

Technical Assistance: High-Level Waste Melter Study Confirms Direction, Recommends Improvements

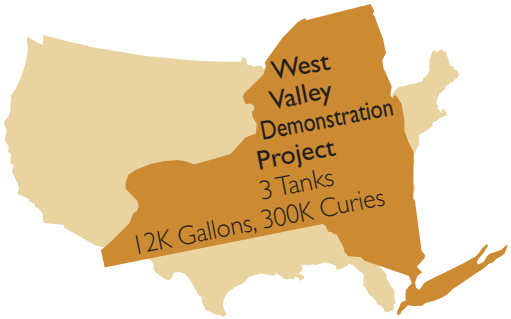
In November 2000, at DOE Headquarters' request, TFA initiated a technical review of alternatives for solidifying Hanford Site HLW that could achieve major cost reductions within reasonable long-term risks. TFA chartered an independent review team of vitrification consultants to lead and guide the technical review and make recommendations for a research and development program for future waste forms and melter developments. A separate study team of vitrification experts was tasked with assessing melter technologies, compiling data, and analyzing existing product requirements to identify improvements in waste loading in waste forms produced in a melter.

> "The TFA continues to help us solve near-term problems and supports our efforts to take advantage of long-term opportunities in all aspects of the River Protection Project. TFA's support in glass development, waste chemistry, retrieval, and chemical separations will enable the Office of River Protection to complete its mission earlier and at a lower cost."
>
> *Joe Cruz, TFA Management Team Site Representative, Office of River Protection*

In July 2001, based on the study team's findings, the review team presented their principal conclusions and recommendations:

- No waste forms were found to be better than the current borosilicate glass form.
- Modest research should be conducted on other silicates and iron phosphate glasses.
- No melters were found better than the current Joule-heated ceramic melter technology.
- Substantial improvements are needed in the current melter technology to achieve higher waste loading and a higher and more predictable processing rate.
- A short but intense research effort should be conducted on the advanced cold crucible melter as a backup to the current technology.
- The biggest challenge in containing the overall life-cycle cost is the development of a total system plan.

Although the review team's findings included recommendations for improvements in vitrification operations and melter technology, it also reinforced the baseline HLW treatment path using Joule-heated melters. TFA will be working with DOE Headquarters and the site users to address the review team recommendations and funding several technology development projects that can potentially be applied to them, benefiting the Hanford Site and other radioactive waste sites across the complex, including the Idaho National Environmental and Engineering Laboratory (INEEL) and the Savannah River Site (SRS).



Gamma Camera and Sampling Tool Advance Tank Waste Characterization (Tech ID 3103)

Tank 8D-2 at the West Valley Demonstration Project (WVDP) was constructed in the 1960s to hold alkaline waste generated by commercial nuclear fuel reprocessing activities. Most of the resulting sludge contained in the tank was removed during previous retrieval efforts, but hard-to-reach residual waste heel remains in the approximately 70-foot-diameter, 27-foot-high tank. TFA is supporting WVDP efforts to characterize residual tank contamination in preparation for tank closure.

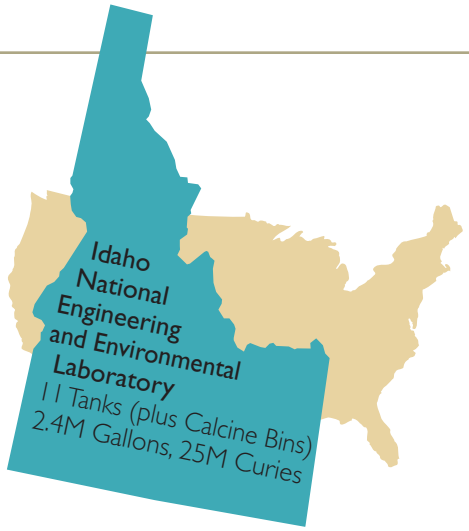
The Gamma Camera, developed in collaboration with WVDP users takes video images, calculates the dose level and curie content in localized areas, and displays the results in colors superimposed on a closed circuit television image. In October 2000, using a hydraulically powered cable/wench system and a tool delivery mast, WVDP operators deployed the Gamma Camera through an access riser and rotated it on two axes. Over 130 images of the tank internal structures and surfaces provided qualitative measurement of the gamma radiation curies present. Results of the Gamma Camera deployment confirmed the effectiveness of prior waste mobilization and tank cleaning activities.

The Gamma Camera captures video images and hot spots and superimposes them for tank characterization. The camera assembly, range finder, and radiation detector are enclosed in a stainless steel case.

To support tank closure activities, samples of the residual waste still must be collected and analyzed. This task requires a tool capable of accessing the tank walls and hard-to-reach areas of the tank amid various internal structures. To obtain representative samples of this remaining waste heel, TFA has developed a Burnishing Sampler Tool that can be lowered into the tank using the WVDP mast-mounted tool delivery system. In March 2001, the site's delivery system successfully deployed the burnishing sampler tool in Tank 8D-2 to collect samples from a variety of tank regions and structures. Analyses of the samples provided key characterization data to support site closure efforts. Modifications of the tool will enable sample collection from the tank floor. This modified version may be deployed in FY 2002.

Using a specialty milling machine bit, the Burnishing Sampler Tool obtains a sample by scraping the tanks' internal surface.

> "The technical resources and funding from TFA have greatly increased our understanding of the residues coating the HLW tank interiors at the WVDP."
>
> *Frederick Damerow, TFA User Steering Group, West Valley Demonstration Project*



Sluicing Spray Ball Removes Tank Waste Heels (Tech ID 3138)

Approximately 1.4 million gallons of radioactive liquid waste is stored in 11 underground stainless steel tanks at INEEL. Sampling and inspection have revealed a layer of light solids at the tank bottom and a thick film adhering to the walls. INEEL's baseline technology for retrieval of tank liquids cannot remove these solids, necessitating the development of additional retrieval technology to mobilize and retrieve them. To help DOE meet terms of a settlement agreement with the state of Idaho and to support tank closure planning, TFA and INEEL have been testing the Tank Heel Retrieval System, which combines a sluicing spray ball to suspend the solids for mobilization and a steam jet transfer pump for removal of solid and liquid material.

The spray ball washing system uses two rotating stainless steel nozzles to remove waste residue from interior tank surfaces.

In FY 2001, testing in a simulated tank environment was first performed on simulated waste using different water pressures and nozzles to measure retrieval performance. The tests demonstrated that tank heels could be moved with different levels of liquid above the solid layers and successfully transferred to a receiving tank. The system removed 90–95% of the solid material, leaving a slurry layer only 1 inch deep. Additional nozzles were also tested to investigate the possibility of improving retrieval efficiency to reduce the amount of liquid required to remove the heel. Adding two variable-direction nozzles to systematically move the remaining sludge toward the pump will result in further recovery.

In August 2001, TFA and INEEL deployed the sluicing spray ball in Tank WM-182. Although the system was operated at lower pressure than originally designed for and demonstrated, it successfully removed portions of the residual waste from the tank walls. The site plans to use the system at full pressure for further cleaning of tank WM-182 and other tanks.

Roadmap Supports Environmental Impact Statement Decision Process (Tech ID 3078)

Approximately 4,400 cubic meters of calcine waste—a highly radioactive mixture of metallic oxides, fluorides, and other dry solids—is stored at INEEL in stainless steel bins. An agreement between INEEL and the state of Idaho requires the waste be ready for transport to off-site disposal by 2035. Although vitrification was previously identified as the preferred treatment method for calcine waste, several options related to that treatment method require further technical investigations to support a recommendation on the appropriate vitrification flowsheet. INEEL developed a technology roadmap to identify the required technical investigations and schedule to address key technical uncertainties and risks.

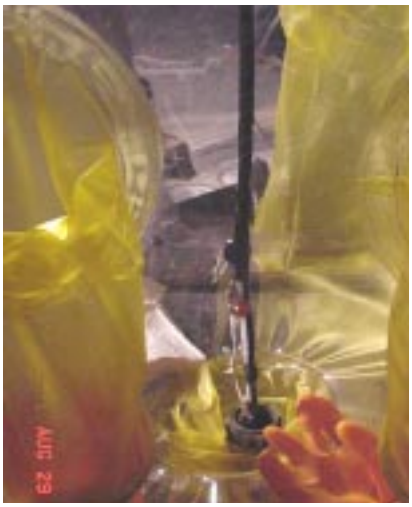
In January 2001, DOE Idaho Operations requested TFA to review the proposed roadmap defining technology development

to support selection of a final treatment method for the calcine waste from three competing alternatives: direct vitrification; full separations using ion exchange, transuranic extraction, and strontium extraction; and full separations using the universal solvent extraction process.

TFA facilitated an expert panel of eight independent reviewers in assessing whether the roadmap was viable, comprehensive, and feasible to implement on both a technical and economic basis. The panel also assessed the timing and required development activities to support decisions on calcine treatment. The panel concluded that the roadmap employed a sound technical approach that, if implemented, would support defensible and successful decision making on the disposition of INEEL calcine. Main areas of emphasis in the panel's preliminary conclusions and recommendations included the advantages and disadvantages of pretreatment prior to vitrification and the potential for accelerating work for downselection of competing pretreatment technologies.

Vault Sump Sampler Design Finalized
(Tech ID 3150)

An agreement between DOE Idaho Operations and the state of Idaho schedules closure of two 300,000-gallon tanks at the Idaho Nuclear Technology and Engineering Center (INTEC) by the end of FY 2004. The INTEC tanks are single-wall structures installed in a secondary containment vault. There have been no known leaks into these vaults; however characterization data on residual contamination levels in the vaults is needed to support closure planning. There is currently no baseline method to sample the tank vaults to measure contamination levels.



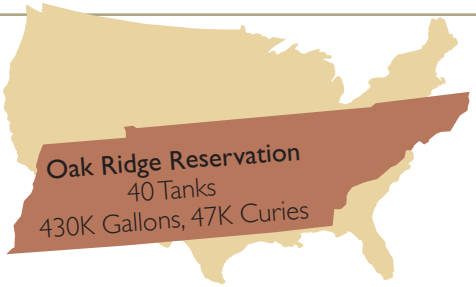
The prototype Vault Sump Sampler begins a 40-foot descent down a 1.7-inch (internal diameter) riser to sample the bottom of a simulated vault sump. The sampler is equipped with a penlight attached just below the bottom of the sample chamber and a side-mounted lead to a video camera.

TFA is assisting INEEL staff in developing a new vault sump sampling technology to sample the sumps and provide the needed characterization data. Following a successful, full-scale demonstration of a vault sump sampler prototype at INEEL in FY 2001, representatives from TFA and INEEL finalized the sampler's design features and scheduled additional steps to prepare for deployment in early FY 2002.

Fernald Site Addresses Silo Waste Retrieval

The Fernald Environmental Management Project is a former uranium processing facility located in southwest Ohio. For nearly 37 years, Fernald produced high-grade uranium metal products for national defense. The processed ore generated from these activities is stored in two 1.5-million-gallon silos. In the early 1990s, a 2-foot layer of a bentonite mixture with the consistency of toothpaste was placed on top of the silo contents as a cap to contain radon gas emissions. The bentonite is expected to aid silo retrieval by raising the buoyancy of the ore.

Fernald's remediation contractor for the silos plans to sluice all of the ore and the bentonite cap out of each silo and transfer it to four new 750,000-gallon storage tanks to await treatment. TFA experts participated in an OST-coordinated technical review of bentonite handling and waste retrieval technology. Technical issues such as sampling, treatability studies on the cap and contents, and the impact of slurrying and separating were addressed.



Pulsating Mixer Pump Empties the Last GAAT (Tech ID 2370)

The 12 Gunite and Associated Tanks (GAAT) constructed in the 1940s at the Oak Ridge Reservation (ORR) were used to collect, neutralize, store, and transfer liquid radioactive and hazardous waste generated by routine facility operations at Oak Ridge National Laboratory (ORNL). One of the GAATs, TH-4, is much smaller than the others and contains unique waste characteristics. TFA and ORR users teamed to develop the Russian Pulsating Mixer Pump (PMP) to retrieve the remaining waste in this tank. After several years of collaboration with Russian scientists and engineers to develop the PMP, it was deployed in Tank TH-4 in January 2001 and successfully removed approximately 25,000 gallons of radioactive waste. On inspection, DOE and state regulators determined that sludge removal was sufficient to permit tank closure. This achievement represents the first successful deployment of a Russian retrieval technology in the U.S. radioactive tanks program. Subsequent uses of this technology are being considered for retrieval of tanks at the Hanford Site.

The Russian Pulsating Mixer Pump mobilized the sludge in GAAT TH-4.

Video Inspection System Moves Tanks towards Closure (Tech ID 2940)

In recent years, TFA has assisted ORR partners in completing retrieval of legacy tank waste and consolidating it in the eight stainless steel Melton Valley Storage Tanks (MVSTs). Built in the 1940s and 1950s, the MVSTs are horizontal cylinders 12 feet in diameter and 62 feet long, each with a 50,000-gallon storage capacity. Inspection of the interior of the tanks must occur to better characterize their condition and map the sludge to achieve a comparative baseline for future use. Visual inspection of the tank interior must be performed remotely with small equipment because access risers at the surface are only 3 inches in diameter.

In FY 2000, TFA began working with ORR users to develop a video inspection system capable of accessing and inspecting the interior of the MVSTs and mapping the sludge. In April 2001, the development team demonstrated the Remote Video Inspection and Mapping System, which comprises three fiber optic light pipes for illumination and three remote cameras: wide-angle color, telephoto color, and low-light telephoto black and white. All cameras are in a 2-inch-diameter cylindrical housing for deployment through narrow tank risers. First deployed in July 2001, the video inspection system successfully captured

> "This last year TFA has been instrumental in assisting Oak Ridge in the development of a process to retrieve and treat a mixture of sludge and TRU-contaminated resins from tanks with a near-term regulatory driver for closure. Also, TFA was very supportive of the Oak Ridge Operations EM-50 Environmental Technology group during the deployment of the Russian Pulsating Mixer Pump, a first-time deployment of a Russian technology for application in underground storage tank wastes."
>
> *Jacquie R. Noble-Dial, TFA Management Team Site Representative, Oak Ridge Operations Office*

video of the interior walls, other internal structures, and waste surfaces in all MVSTs. Data from this inspection provided key information required to support privatization of waste removal from the MVSTs.

Corrosion Monitoring Improvements for Safe Waste Storage (Tech ID 1985, 3076)

Stainless steel electrodes were used to study the relationship between uniform corrosion rate and electro-chemical noise.

Electrochemical noise (EN) technology provides the capability for real-time monitoring of corrosion processes and rates. EN probes and an integrated monitoring system are currently operating in carbon-steel double-shell tanks at the Hanford Site. TFA and ORNL are working with users at the Hanford Site and technology experts from industry to transfer the EN corrosion probe and corrosion inhibitor monitor system technology for use in ORR's stainless steel tanks.

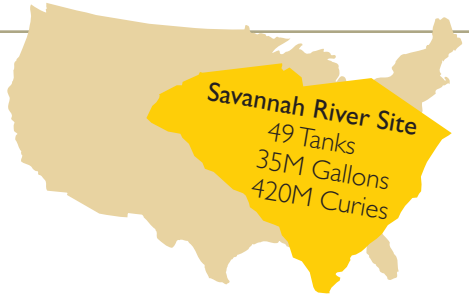
Testing and development efforts for adapting the monitoring system began in October 2000. Following successful acceptance testing in June 2001, the adapted system was installed in Tank W-23. Information gathered from the deployment will be assessed further for application at INEEL for monitoring acidic waste contained in that site's stainless steel tanks.

> "TFA continues to be a resource for providing technologies and analytical tools for all the HLW sites. In addition, TFA plays an important role in evaluating candidate technologies that are proposed for individual site HLW programs. These activities include the advanced melter study conducted for Hanford and INEEL HLW programs and the review of technologies proposed for treating INEEL HLW during development of their program environmental impact statement."
>
> *Ken Picha, Office of Integration and Disposition*

Focus Areas Work Together to Advise Separations Process Research Unit

The Separations Process Research Unit (SPRU), an inactive pilot plant located at the Knolls Atomic Power Laboratory near Schenectady, New York, developed chemical processes for separating plutonium and uranium from irradiated fuel. Separate buildings house tanks used to dissolve irradiated fuel targets and to neutralize waste materials. In addition, outdoor vaults contain drained waste tanks that still contain sludge heels. These tanks are believed to contain waste contaminated with plutonium, highly enriched uranium, cobalt-60, americium, mixed fission products, and other irradiated metals from hot cell activities.

In January 2001, the SPRU Remediation Project team of the DOE Oakland Operations Office met with representatives of the Tanks, Subsurface Contaminants, and Deactivation and Decommissioning Focus Areas to discuss integrated technical assistance required for characterizing and remediating the SPRU facility. TFA representatives provided information about tank characterization approaches and tools, focusing on applicable sampling, analysis, and quality assurance methods. Sampling technologies discussed included a manual core sampler developed for obtaining heel samples directly under a riser; a power fluidic waste sampling, mixing, and retrieval system for application at the INEEL; and simple arms and endoscope technology being developed for use at Hanford. This focus area integration ensured that characterization efforts at SPRU take advantage of technical expertise and emerging technology from across the DOE complex.



TFA-Managed Research and Development Enables Technology Selection for the Salt Processing Project (Tech ID 21, 841, 3088, 3089)

In March 2000, at DOE's request, TFA assumed management of the R&D efforts associated with the Salt Processing Project (SPP) at the Savannah River Site. This responsibility included reviewing and revising the technology development roadmaps, developing selection criteria, and preparing a comprehensive R&D program plan for three candidate cesium removal technologies as well as the alpha and strontium removal technologies that are part of the overall SPP. Data from these investigations supported the ultimate selection of a preferred cesium removal process in July 2001.

> "In FY 2001, TFA worked closely with SRS and the Office of Projection Completion to evaluate alternatives for fission products and actinide separation of SRS's salt HLW. This evaluation culminated in the selection of Caustic-Side Solvent Extraction to treat HLW. This research and development has shown how effective TFA is at developing and deploying innovative technologies to expedite environmental cleanup. I look forward to their continued dedicated involvement in the future to help EM achieve its cleanup goals."
>
> *Mark Frei, Deputy Assistant Secretary for Project Completion*

Alpha and Strontium Removal Technologies

The baseline technology is sorption using monosodium titanate (MST), followed by removal of MST and entrained sludge solids with crossflow filtration. SPP researchers performed experiments to determine the ability of alternative separation sorbents that target strontium and alpha-emitting actinides. A demonstration with simulated waste provided precipitation performance information for strontium and actinides when nonradioactive strontium, calcium, and sodium permanganate are added. The results of this demonstration will provide options relative to the current SRS baseline technology.

Cesium Removal Technologies

- **Small Tank Tetraphenylborate Precipitation** technology was tested on actual SRS HLW in two-stage continuous stirred tank reactors. Testing was conducted at both normal operating and extreme temperatures. Operation remained stable throughout the tests. Removal efficiencies for both cesium-137 precipitation and strontium-90 sorption exceeded target specifications. The tests increased understanding of the catalytic decomposition of tetraphenyl borate that caused the previous technical challenges of cesium removal from salt waste.

- **Ion Exchange Using Crystalline Silicotitanate (CST)** requires an adsorption filtration step to remove strontium, uranium, and plutonium from the waste using MST and then removes the cesium by ion exchange on the CST. The loaded CST is then washed and transferred to the Defense Waste Processing Facility for vitrification. To address concerns related to temperature, stability, waste composition, and gas generation, TFA funded additional testing of a CST material to measure removal efficiencies, examine leaching of the material upon exposure to highly alkaline solutions, and perform several characterization activities. Equilibrium measurements indicated that available models adequately predict cesium loading from a variety of SRS wastes. Sorption kinetics results were nearly identical in tests with simulated and actual SRS

radioactive waste, indicating that modeling parameters are adequate for predicting radioactive waste performance.

- **Caustic-Side Solvent Extraction (CSSX)** uses an insoluble solvent containing a chemical extractant that selectively removes cesium ions from caustic wastes. The decontaminated waste stream is sent to the Saltstone Facility for disposal, and the cesium is stripped into a dilute nitric acid for transfer to the Defense Waste Processing Facility. In March 2001, a demonstration was successfully completed using the CSSX flowsheet. Subsequent tests with real waste at Savannah River Technology Center achieved decontamination factors exceeding requirements to meet the salt processing waste acceptance criteria.

> "A key strength of the Tanks Focus Area is its ability to respond quickly to assist users in tackling emerging technical challenges. At SRS, TFA has done an excellent job of this. For example, SRS's capability to manage its HLW tank farm inventories was severely constrained in FY 2001 when solids deposited in one of its HLW evaporators. TFA provided invaluable assistance to SRS in recovering from this previously unencountered problem."
>
> *Thomas Gutmann, TFA Management Team Site Representative, Savannah River Operations Office*

Caustic-Side Solvent Extraction test equipment demonstrated the technology's capability for deployment in the planned Salt Waste Processing Facility.

DOE Selects CSSX as Preferred Cesium Removal Technology

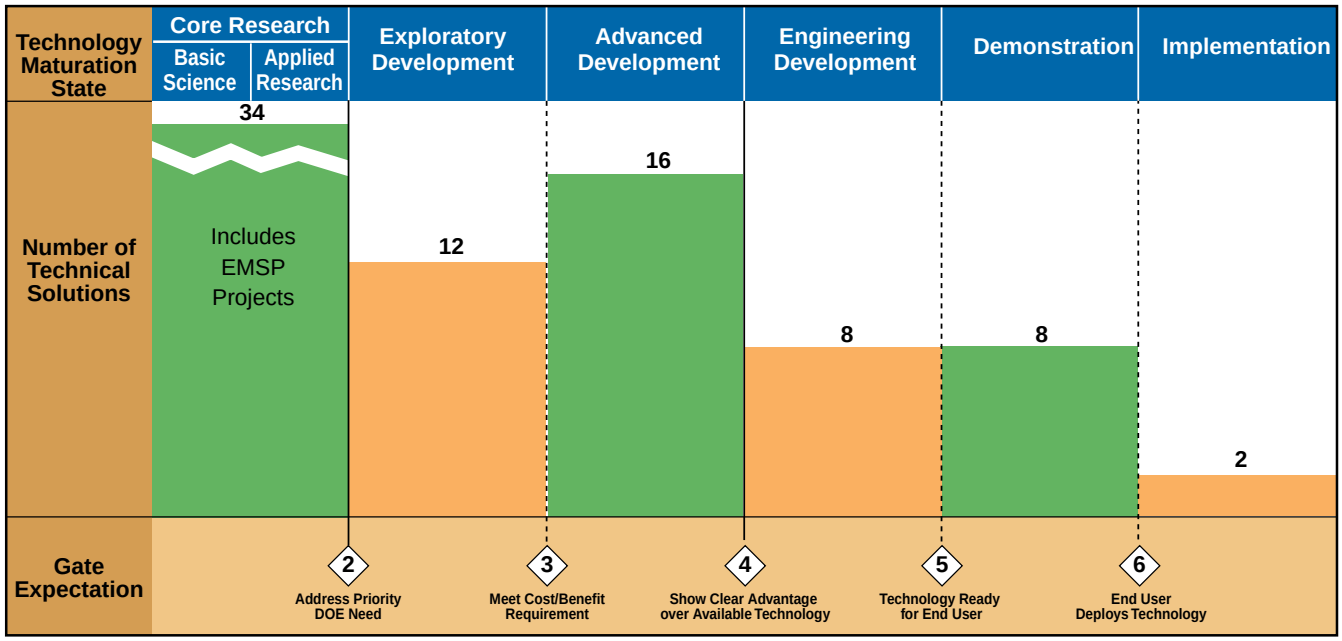
The SPP Technology Downselection Technical Working Group and Management Review Board, met in May 2001 at SRS to hear presentations by the TFA SPP management and DOE Savannah River. Based on the data and management recommendations, DOE selected CSSX as the preferred cesium removal technology, and the decision was documented in the SRS Supplemental Environmental Impact Statement, published in the Federal Register in July 2001 and in a record of decision in October 2001. DOE has asked TFA to continue leading R&D efforts on CSSX along with alpha and strontium removal technologies to provide input for conceptual and preliminary design of the Salt Waste Processing Facility, as well as limited backup technology R&D. Technology summary reports and final discussion reports are available through the TFA Web site.

Innovative Technology Summary Reports

TFA published six new Innovative Technology Summary Reports (ITSRs) in FY 2001, signaling the technologies' "Ready-for-Implementation" status to DOE users and others working in the environmental industry. A total of 33 ITSRs, as listed below, now describe how risks and costs can be reduced through TFA technology implementation. Published ITSRs are available on the OST Web site at http://www.em.doe.gov/ost under "Publications."

Download (Tech ID)	To learn about
Safe Waste Storage	
Corrosion Probe (1985)	Controlling corrosion, maintaining tank integrity
Fluidic Sampler (2007)	Remotely operated, stationary sampler for process tanks
Laser Ablation/Mass Spectroscopy (127)	Chemical analysis method for tank waste
Near-Infrared Spectroscopy (86)	Measuring water content in waste samples
Robotic Tank Inspection End Effector (278)	Visual and electromagnetic nondestructive evaluation
Stereo Viewing System (890)	Stereoscopic viewing of tank interiors
Topographical Mapping System (130)	Charting the inside of waste storage tanks
Retrieval	
Advanced Waste Retrieval System (2948) NEW	Telescopic arm for waste retrieval on the tank floor
AEA Fluidic Pulse Jet Mixer (1511)	Low-maintenance equipment for mobilizing settled solids
Borehole Miner (1499)	High-pressure sluicing nozzle to mobilize tank waste
Comparative Testing of Slurry Monitors (1547)	Real-time measurement of slurry rheological properties
Confined Sluicing End Effector (812)	Dislodging waste using high-pressure, rotating water jets
Heavy Waste Retrieval System (2194) NEW	Tank floor cleaning system for retrieval of nonpumpable tank waste
Houdini: Reconfigurable In Tank Mobile Robot (98)	Mobile robot to assist waste retrieval and mobilization
Houdini-II Remotely Operated Vehicle System (2085)	Mobile robot to assist waste retrieval and mobilization
Light Duty Utility Arm (85)	Mobile, multiaxis robotic arm for in tank applications
Pulsed-Air Mixer (1510)	Using air bubbles to mix tank contents
Russian Pulsating Mixer Pump (2370) NEW	Reciprocating, air-operated mixer pump to mobilize tank sludge
Pretreatment	
Caustic Recycle (885)	Membranes for removing sodium from waste
Cesium Removal Using Crystalline Silicotitanate (21)	Cesium removal using high-capacity sorbent to reduce volume of HLW
Crossflow Filtration(350)	Solid/liquid separation methods
Out-of-Tank Evaporator (20)	Modular evaporator to reduce waste volume
Sludge Washing (233)	Caustic leaching of nonradioactive chemicals
Thermal Denitration (2371) NEW	Removing nitrate and nitrite to reduce the volume of HLW
TRUEX/SREX (347)	Radionuclide removal from HLW
Immobilization	
Vitrification of Ion Exchange Materials (81)	Glass formulations for ion-exchange sorbents
Closure	
Gunite Scarifying End Effector (2384) NEW	Water jet nozzles capable of scarifying gunite tank walls
Heel Sampling End Effector (2386)	Sampling tank waste heels
Multipoint Grout Injection System (2368) NEW	Injecting, mixing, and immobilizing chemical agents with residual waste
Raman Probe (1544)	Analysis of organic and inorganic chemical species
Pipe Cutting and Isolation System (2093)	In-tank cutting, cleaning, and plugging of pipes
SRS Tank Closure (22)	Technologies for closing tanks
Vadose Zone Characterization System (2118)	Sensory system which measures subsurface contaminants

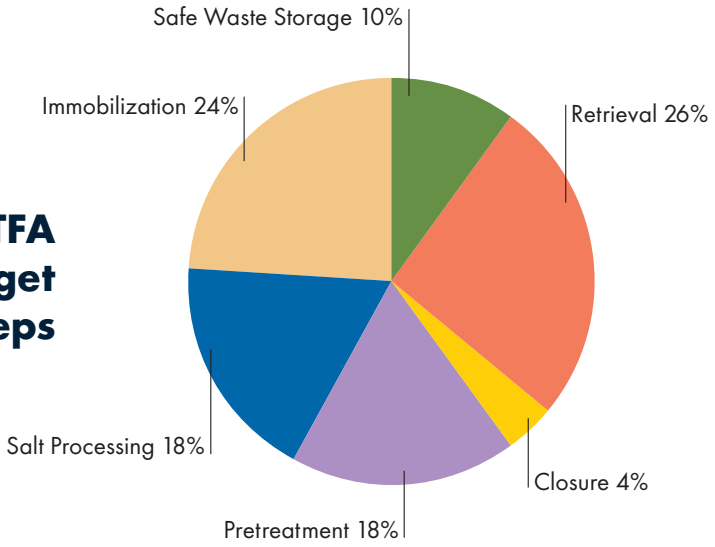
Portfolio Distribution of Technical Solutions by Maturity Stage



EMSP Research Projects

TFA Problem Element	Total Active Projects	Total FY 2001 Funding ($K)	Sites' Needs Addressed
Characterization & Processing	6	$476	Hanford, SRS, INEEL, ORR
Retrieval & Remote Systems	2	$496	Hanford, SRS, INEEL
Tank Closure & Final Waste Forms	4	$966	Hanford, SRS, INEEL
Pretreatment	16	$4,786	Hanford, SRS, INEEL, ORR
Immobilization	5	$1,248	Hanford, SRS, INEEL, ORR

Distribution of TFA FY 2001 Program Budget by Process Steps



FY 2001 TFA Projects

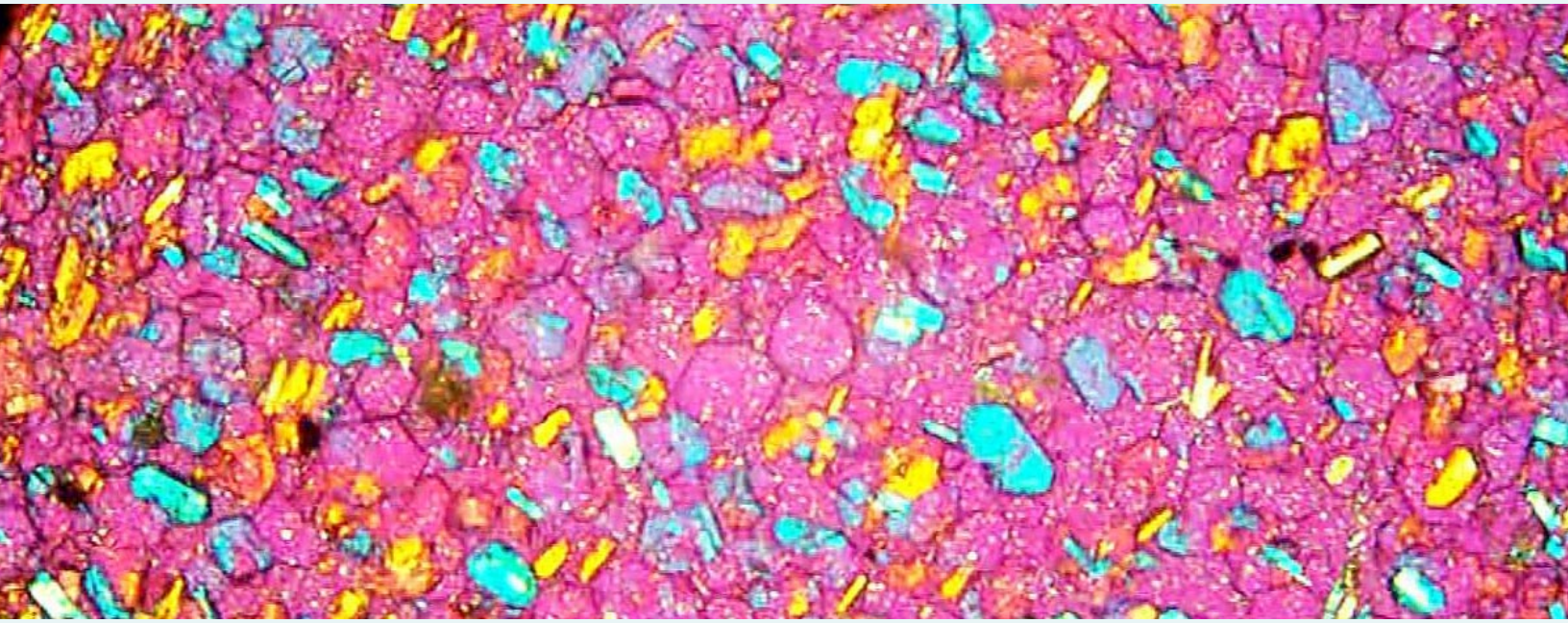
Process Step	Project Title (Technical Response ID)	Technologies Used in Project (Tech ID)	Site (Site Need ID)	PBS Served	Total Funding ($K)
Safe Waste Storage	HLW Tank Corrosion Control and Monitoring (A9143)	Raman Corrosion Species Monitor (1544) Electrochemical Noise Corrosion Monitor System (1985) Electrochemical Noise Corrosion Monitoring for Stainless Steel Tanks (3076)	SRS (SR00-2045) Hanford (RL-WT04) Hanford (RL-WT079) ORNL (ORTK-01)	SR-HL01 SR-HL02 SR-HL03 RL-WT03 OR-151	1,011
	Tank Leak Mitigation (A9157)	Tank Leak Mitigation (3101)	Hanford (RL-WT027) SRS (SR00-2028)	RL-WT03 SR-HL01 SR-HL02 SR-HL03	350
	Alternative Air Filtration Technology (A9171)	Alternative Filtration Technologies for Calcine Transfer (3099) Alternative Filtration for SRS Tanks (2091)	INEEL (ID-2.1.27) SRS (SR00-2027)	ID-HLW-103 SR-HL01 SR-HL02	576
	Tank Integrity Inspection Techniques (A9175)	Tandem Synthetic Aperture Focusing Technique for Ultrasonic Inspection (3094) ORNL MVST Camera System (3095) Small Roving Annulus Inspection Vehicle (3096) Evaluate Interim Tank Storage Configuration (3097)	Hanford (RL-WT05) Hanford (RL-WT022) Hanford (RL-WT067) INEEL (ID-2.1.20) ORNL (ORTK-01) SRS (SR00-2035) SRS (SR00-2037) WVDP (OH-WV-907)	RL-WT03 ID-HLW-105 OR-151 SR-HL01 SR-HL02 SR-HL03 OH-WV-01	1,775
	Slurry Transfer and Tank Waste Mixing Monitors (A9278)	Dual Coriolis Meters for Pipeline Slurry Monitoring (2970)	Hanford (RL-WT09) Hanford (RL-WT032) INEEL (ID-2.1.67) ORNL (ORTK-04) SRS (SR00-2037) SRS (SR00-2044)	RL-TW01 RL-TW05 ID-HLW-103 OR-321 SR-HL01 SR-HL02 SR-HL03	515
	Pre-Closure Interim Tank Maintenance (AA1S1)	Pre-Closure Interim Tank Maintenance (3071)	Hanford (RL-WT05) Hanford (RL-WT-013) Hanford (RL-WT021) Hanford (RL-WT022) Hanford (RL-WT027) Hanford (RL-WT067) INEEL (ID-2.1.20) INEEL (ID-2.1.72) ORNL (ORTK-01) SRS (SR00-2035) SRS (SR00-2037) WVDP (OH-WV-907)	RL-TW01 RL-TW03 RL-WT04 ID-HLW-103 ID-HLW-105 OR-151 SR-HL01 SR-HL02 SR-HL03 OH-WV-01	50
Retrieval	Waste Sampling and At-Tank Analysis (A9246)	Variable Depth Fluidic Sampler (2119)	Hanford (RL-WT09)	RL-TW01 RL-TW05	491
	Remote Systems for Pit Operations and Maintenance (A9352)	Tank Riser Pit Decontamination System (2195) SRS Pit Operations Enhancements (TBD)	Hanford (RL-WT021) SRS (SR00-2037)	RL-TW03 SR-HL01 SR-HL02 SR-HL03	1,000
	Waste Mixing and Retrieval (A9359)	Mixer Pump Operational Improvements (2408)	SRS (SR00-2028) SRS (SR00-2037) ORNL (ORTK-02) Hanford (RL-WT060) Hanford (RL-WT054) SRS (SR00-2041)	SR-HL01 SR-HL02 SR-HL03 OR-321 RL-TW04	1,655

Process Step	Project Title (Technical Response ID)	Technologies Used in Project (Tech ID)	Site (Site Need ID)	PBS Served	Total Funding ($K)
Retrieval	Heel Retrieval from Obstructed Tanks (A9361)	Advanced Waste Retrieval System(2948) Sampling End-Effector for West Valley Tanks (2941) INEEL Tank Heel Retrieval (3138)	WVDP (OH-WV-905) INEEL (ID-2.1.67)	OH-WV-01 ID-HLW-103	1,225
	Saltcake Dissolution Retrieval (A9362)	Low-Water Salt Dissolution Retrieval (3100)	Hanford (RL-WT063) Hanford (RL-WT077) SRS (SR00-2028)	RL-TW04 SR-HL01 SR-HL02 SR-HL03	1,357
	Chemical Cleaning of Tanks (A9363)	Chemical Cleaning for Caustic Waste Storage Tanks (2967) Chemical Cleaning for Acid Waste Storage Tanks (3104)	SRS (SR00-2037)	SR-HL01 SR-HL02 SR-HL03	600
	Waste Transfer Pumping (A9365)	Variable Depth Transfer Pump (3091) Temporary Transfer Lines (3092)	INEEL (ID-2.1.67) SRS (SR00-2037) Hanford (RL-WT062)	ID-HLW-103 SR-HL01 SR-HL02 SR-HL03 RL-TW04	375
	Unobstructed Tank Heel Retrieval (A9367)	SRS Tank Heel Retrieval (2097) In-Tank Waste Retrieval- Vehicle Based System (2012) GAAT Retrieval (85, 812, 2085)	ORNL (ORTK-02) Hanford (RL-WT013) Hanford (RL-WT064) SRS (SR00-2037)	OR-321 RL-TW04 SR-HL01 SR-HL02 SR-HL03	1,858
	Waste Transfer Line Plugging Prevention and Unplugging Methods (A9376)	Pipe Unplugging (2367)	SRS (SR00-2039)	SR-HL01 SR-HL02 SR-HL03	1,672
	Horizontal and Small Tank Sludge Mixing and Retrieval (A9382)	Small Tank and Piping Retrieval (3109)	Hanford (RL-WT085) ORNL (ORTK-02) SRS (SR00-2037) WVDP (OH-WV-905)	RL-WM05 OR-321 SR-HL01 SR-HL02 SR-HL03 OH-WV-01	275
	Selective Chemical Dissolution of Tank Heels to Improve Retrieval (AA3S1)	Selective Chemical Dissolution of Tank Heels to Improve Retrieval (3072)	Hanford (RL-WT023) Hanford (RL-WT024) Hanford (RL-WT060) Hanford (RL-WT064) Hanford (RL-WT070) Hanford (RL-WT071) SRS (SR00-2028) SRS (SR00-2037)	RL-TW04 RL-TW01 SR-HL01 SR-HL02 SR-HL03	200
	Single Shell Tank Retrieval from Potential Leaking Tanks (AA3S2)	Single Shell Tank Retrieval from Potential Leaking Tanks (3073)	Hanford (RL-WT013) Hanford (RL-WT027) Hanford (RL-WT063) Hanford (RL-WT064) Hanford (RL-WT077) ORNL (ORTK-02) SRS (SR00-2028) SRS (SR00-2037)	RL-TW03 RL-TW04 OR-321 SR-HL01 SR-HL02 SR-HL03	150
Pretreatment	INEEL Integrated Radionuclide Separations Process (A9501)	Universal Solvent Extraction (UNEX) (841)	INEEL (ID-2.1.06) INEEL (ID-2.1.56) INEEL (ID-2.1.68)	ID-HLW-101 ID-HLW-103	450
	Decon Process Waste Volume Reduction (A9508)	Decontamination Methods Development (3137)	INEEL (ID-2.1.16) INEEL (ID-2.1.17)	ID-HLW-101	450

Process Step	Project Title (Technical Response ID)	Technologies Used in Project (Tech ID)	Site (Site Need ID)	PBS Served	Total Funding ($K)
Pretreatment	Hanford Tank Waste Chemistry (A9554)	Saltcake Dissolution (1989) Waste Transport Chemistry and Solids Formation (3079) Evaporator Chemistry and Operational Improvements (3087)	Hanford (RL-WT063) Hanford (RL-WT071) Hanford (RL-WT023) Hanford (RL-WT040) Hanford (RL-WT049) Hanford (RL-WT075) Hanford (RL-WT078) ORNL (ORTK-04) SRS (SR00-2037) SRS (SR00-2039)	RL-TW01 RL-TW03 RL-TW04 OR-321 SR-HL01 SR-HL02 SR-HL03	3,875
	Sludge Washing and Dissolution (A9555)	Sludge Washing (233)	Hanford (RL-WT024) Hanford (RL-WT037) Hanford (RL-WT038) Hanford (RL-WT070) Hanford (RL-WT078) ORNL (ORTK-05) SRS (SR00-2052)	RL-TW01 RL-TW04 OR-151 OR-311 SR-HL02 SR-HL05	1,662
	Vitrification Recycle (A9566)	Vitrification (DWPF) Recycle (3110)	SRS (SR00-2033)	SR-HL01 SR-HL02 SR-HL03	50
	Salt Disposition (A9570)	Cesium Removal Using CST (21) Advanced Integrated Solvent Extraction Systems (204) Salt Processing Project-Tetraphenylborate (3088) Salt Processing Project (3089)	Hanford (RL-WT082) INEEL (ID-2.1.28) ORNL (ORTK-11) SRS (SR00-2034)	RL-TW05 ID-HLW-103 OR-311 SR-HL13	7,620
	Calcine Separations (A9584)	Cross Flow Filtration (350) Calcine Dissolution Studies (881)	INEEL (ID-2.1.64)	ID-HLW-103	400
	Wastewater Triad (A9586)	Out of Tank Evaporator (20)	ORNL (ORTK-05) ORNL (ORTK-11) SRS (SR00-1011)	OR-151 OR-311 SR-SW01	200
	Removal of Key Non-Radioactive Elements from Tank Waste (AA5S1)	Removal of Key Non-Radioactive Elements from Tank Waste (3074)	Hanford (RL-WT024) Hanford (RL-WT037) Hanford (RL-WT038) Hanford (RL-WT070) Hanford (RL-WT078) ORNL (ORTK-05) SRS (SR00-2052)	RL-TW01 RL-TW04 OR-151 OR-311 SR-HL02 SR-HL05	250
Immobilization	Waste Treatment Process Flowsheet Model (A9709)	Waste Treatment Process Flowsheet Model (3090)	INEEL (ID-2.1.24) INEEL (ID-2.1.65) SRS (SR00-2055)	ID-HLW-103 SR-HL05	600
	Conditioning and Immobilization of Low-Activity Waste Forms (A9719)	Conditioning and Immobilization of Low-Activity Waste Forms (82)	INEEL (ID-2.1.23) INEEL (ID-2.1.28) INEEL (ID-2.1.35) INEEL (ID-2.1.38) INEEL (ID-2.1.40) INEEL (ID-2.1.66) ORNL (ORTK-06)	ID-HLW-103 OR-151 OR-311	830
	Testing and Prediction of Long-Term Waste Glass Performance (A9748)	Testing and Prediction of Long-Term Glass Performance (3102)	Hanford (RL-WT015) Hanford (RL-WT066)	RL-TW09	1,000
	Specify and Enhance Design of HLW Glass Melters (A9768)	DWPF Melter Pouring Enhancements (2092) Joule Heated Melter Improvement Studies (3077) Melter Technology for Sodium Bearing Waste and Calcine Vitrification (3078)	INEEL (ID-2.1.57) INEEL (ID-2.1.66) SRS (SR00-2036) Hanford (RL-WT080) INEEL (ID2.1.58)	ID-HLW-103 SR-HL01 SR-HL02 SR-HL03 RL-TW04	3,150

Process Step	Project Title (Technical Response ID)	Technologies Used in Project (Tech ID)	Site (Site Need ID)	PBS Served	Total Funding ($K)
Immobilization	Improve Waste Loading in HLW Glass (A9773)	HLW Glass Improvements (3107) INEEL Glass Formulations Development (2009)	Hanford (RL-WT080) Hanford (RL-WT081) Hanford (RL-WT084) INEEL (ID-2.1.58) INEEL (ID-2.1.66) SRS (SR00-2032) SRS (SR00-2036)	RL-TW04 RL-TW05 ID-HLW-103 SR-HL05	2,310
	Remote Disassembly of HLW Melters and Other Processing Equipment (A9777)	Vitrification Expended Material Processing System (2383) Melter Glass Removal Methods (3098) Dismantlement Size Reduction of Failed Vit Equipment (2942)	WVDP (OH-WV-903) SRS (SR00-2040)	OH-WV-01 SR-HL05	595
	New Melter Technology (AA7S2)	High Temperature Cold Crucible Induction Heated Melter (3075)	Hanford (RL-WT080) INEEL (ID-2.1.57) INEEL (ID-2.1.58) INEEL (ID-2.1.66) SRS (SR00-2032) SRS (SR00-2036)	RL-TW05 ID-HLW-103 SR-HL05	454
	Argentina Resin Vitrification Support (N/A)		N/A	N/A	350
	Melter Study (N/A)		N/A	N/A	406
	Alternative HLW Canister Decontamination (A9772)		WV (OH-WV-702)	OH-WV-01	250
Closure	Enhanced Grout Formulations for Tank Closure (A9923)	Grout Formulations for Tank Closure (3093)	INEEL (ID-2.1.46) INEEL (ID-2.1.47) ORNL (ORTK-09) SRS (SR00-3022) WVDP (OH-WV-914)	ID-HLW-105 OR-321 SR-ER02 OH-WV-01	550
	In-Situ Waste Characterization (AA202)	WV IN-Tank Radiological Measurement Methods (3103)	Hanford (RL-WT031) SRS (SR00-2044) WVDP (OH-WV-906)	RL-TW01 SR-HL01 SR-HL02 SR-HL03 OH-WV-01	225
	Residual Waste Sampling (AA203)	Sampler for INEEL, SRS (3150) VCO Tank Sampling and Retrieval System (TBD)	Hanford (RL-WT013) INEEL (ID-2.1.72) SRS (SR00-2037)	RL-TW04 ID-HLW-103 SR-HL01 SR-HL02 SR-HL03	675
	TOTAL TECHNICAL BUDGET				41,487

Tanks Focus Area Program Lead—Ted Pietrok • 509.372.4546 • Tanks Focus Area Program Manager—Kurt Gerdes • 301.903.7289



Tanks Focus Area—http://www.pnl.gov/tfa • Office of Science and Technology—http://www.em.doe.gov/ost