

## **TECHNOLOGY SUCCESSES IN HANFORD TANK WASTE STORAGE AND RETRIEVAL**

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### **ABSTRACT**

The U. S. Department of Energy (DOE), Office of River Protection (ORP) is leading the River Protection Project (RPP), which is responsible for dispositioning approximately 204,000 cubic meters (54 million gallons) of high-level radioactive waste that has accumulated in 177 large underground tanks at the Hanford Site since 1944. The RPP is comprised of five major elements: storage of the waste, retrieval of the waste from the tanks, treatment of the waste, disposal of treated waste, and closure of the tank facilities. Approximately 3785 cubic meters (1 million gallons) of waste have leaked from the older "single-shell tanks." Sixty-seven of the 147 single shell tanks are known or assumed "leakers." These leaks have resulted in contaminant plumes that extend from the tank to the groundwater in a number of tank farms. Retrieval and closure of the leaking tanks complicates the ORP technical challenge because cleanup decisions must consider the impacts of past leaks along with a strategy for retrieving the waste in the tanks.

Completing the RPP mission as currently planned and with currently available technologies will take several decades and tens of billions of dollars. RPP continue to pursue the benefits from deploying technologies that reduce risk to human health and the environment, as well as, the cost of cleanup. This paper discusses some of the recent technology partnering activities with the DOE Office of Science and Technology activities in tank waste retrieval and storage.

### **INTRODUCTION**

The U.S. Department of Energy (DOE) Office of River Protection (ORP) River Protection Project (RPP) is responsible for retrieving, treating, immobilizing, and disposing of the 204,000 cubic meters ( $m^3$ ) or 54,000,000 gallons (gal) of high-level waste (HLW) that have accumulated in large underground tanks at the Hanford Site since 1944. This paper discusses some of the recent successes the storage and retrieval of tank waste at RPP.

The current plan for the initial quantity requires that ORP treat no less than 10% on a mass basis, 25% percent on a radioactivity basis by 2018. The balance of mission will complete the remainder of treatment prior to 2028. There are significant challenges to overcome and opportunities to explore for the balance of mission.

Technology advances are critical to the success of RPP. In a simple comparison, RPP is larger and more complex than the combination of some of the DOE's smaller sites. More reactor fuel

reprocessing approaches were employed at Hanford than the total of approaches used at the same sites. Hanford has more known or assumed leaking tanks than the total of similar tanks at the West Valley Demonstration Project, Idaho National Engineering and Environmental Laboratory, and Savannah River Site combined. To meet this challenge, technologies have been selected for use based on their maturity and suitability for anticipated future conditions. However, RPP continues to evaluate potentially improved/new approaches that could provide confidence that the Hanford tank cleanup can further reduce risks to people and the environment earlier while reducing cost.

## **Hanford Tanks**

The tanks at the Hanford Site are constructed of reinforced concrete with either one or two carbon steel liners. Most tanks are 23 meter (m) or 75 feet (ft) in diameter with a capacity of 1893 m<sup>3</sup> (500,000 gal) to 3785 m<sup>3</sup> (1 million gal) (1). Approximately 3785 m<sup>3</sup> (1 million gal) of waste have leaked from 67 of the 149 older single-shell tanks (SSTs) (2). No waste has leaked from the 28 newer double-shell tanks (DSTs). The tanks are grouped into 18 “farms” spread across the 200 East and 200 West Areas of the Hanford Site.

These tanks have a wide variety of access ports or “risers,” internal obstacles, and installed equipment. The structural integrity of the tanks varies as well. The in-tank environment includes thermal, chemical, and radiation hazards. In-tank equipment must be designed to survive this challenging environment with minimal maintenance. If the equipment were removed for maintenance or repair, there would be substantial dose to workers and increased costs. Unfortunately, nearly every tank is unique. Variability in waste volume and characteristics, tank and equipment configuration, and tank condition requires robust and adaptable solutions.

## **Tank Waste Description**

Hanford’s tank waste inventory includes the following:

- Saltcake is a crust of salt material that typically resides on the uppermost layer of the tank. Saltcake is formed when tank waste that has been concentrated by evaporation is returned to a tank and cools. As the temperature of the concentrated solution decreases, the crystallized salts form. Saltcakes vary in consistency from wet sand to concrete.
- Supernatant liquids reside either above or within saltcakes (if they are present) and typically contain nitrates, phosphates, and other chemicals with a relatively small amount of suspended solids.
- Slurries are a mixture of solid particles suspended in liquid.
- Sludges are thick and dense combinations of liquids and solids. The liquid fraction of sludge is called “interstitial liquid” and is usually similar to the supernatant liquid. The solid fraction is mostly insoluble metal hydroxides and oxides precipitated from neutralized waste.
- Some miscellaneous items have been abandoned in tanks. These items range from small hand tools to pump assemblies.
- Approximately 35% of the waste volume resides in the DSTs and 65 % resides in the SSTs.

Table I is a summary of the tank waste inventory. Wastes vary significantly and the limited set of historical information does not meet current data needs. Hanford has an extensive characterization and data reconstruction program to supply this vital information. While progress has been made (specifically for those constituents relevant to safety) and the inventory for the initial quantity is well understood, uncertainty in the tank inventory is a key component to determine the best technical approach for the balance of mission.

Table I. Summary of Tank Waste.

<b>Inventory</b>	<b>Double-Shell Tanks</b>	<b>Single-Shell Tanks</b>
Total, m <sup>3</sup> (gal)	72,000 (19,000,000)	128,000 (34,000,000)
Average density, kg/m <sup>3</sup> (lb/in. <sup>3</sup> )	1500 (0.0542)	1600 (0.0578)
Chemicals, kg (tons)	50,000 (55,000)	173,000 (190,000)
Water (drainable/nondrainable), m <sup>3</sup> (gal)	59,000 (15,600,000)	36,000 (9,400,000)
Radioactivity, TBq (Ci)	3 (80,000,000)	4 (110,000,000)
NOTE: Data are rounded numbers and estimates provided for informational purposes only (1).		

## RPP STORAGE AND RETRIEVAL ACTIVITIES

During fiscal years (FY) 2000 and 2001, ORP and its contractors have renewed their emphasis on technology development and their participation in the DOE technology development initiatives. Every activity in this paper has been conducted in partnership with the DOE Office of Science and Technology (OST) Tanks Focus Area (TFA) to make best use of the available resources, maximize utilization of expertise, and facilitate the transfer of data among the technical community. This partnership continues to be an element critical to the success of the activities mentioned here:

- Pit Viper,
- Single-Shell Tank Retrieval Technology,
- Saltcake Dissolution Proof-of-Concept Demonstration,
- Leak Detection, Mitigation, and Monitoring, and
- Cold Test Facility.

## Pit Viper

One of the most exciting new technology activities is the “Pit Viper” system. Hanford’s 177 tanks have approximately 600 “pits,” which are concrete structures that provide a contained interface for tank equipment installation and connections between pipelines and tanks. The pits vary based on the tank configuration and intended use of the pit. The pits extend downward from grade level and vary in size, but have a height, width, and depth similar to a small room. Waste transfer lines, jumpers, pumps, and miscellaneous debris can be found in these pits. Many pits must be accessed in the next few years as part of ongoing retrieval activities.

Performing work in the pits is a significant challenge. Pits can be contaminated with tank waste and many require the use of long-handled tools to perform work. Radiation levels in the pits can be as high as 0.5 Gray/hour (50 RAD/hour). Current pit operations are performed manually from behind shielded panels, often using long-handled tools. These operations are slow, tedious, time consuming, and expensive. Additionally, pit work is the most radiation dose-intensive task for RPP.

The “Pit Viper” consists of a robotic arm mounted to a backhoe, a remote viewing system, and a control trailer. The backhoe is used to move the arm into the pit area and provides a convenient transport platform. The manipulator arm is controlled by an operator situated at a remote console located in a trailer outside the tank farm. Cameras mounted to the robotic arm as well as in and around the pit allow the operator to see the entire pit area. The system is capable of using a variety of tools, some of which are commercially available. The control trailer includes the Compact Remote Operator Console, developed previously by the Robotics Crosscutting Program (RBX), that provides multiple simultaneous views to the operator. The entire system is designed to be easily and rapidly deployed in the field.

On December 17, 2001, the “Pit Viper” was deployed in the pit of tank 241-C-104 (C-104) at the Hanford Site. On the first day, the “Pit Viper” used a water knife to cut a thick sheet of foam insulation in the pit and remove dirt and paint from a wall. On the second day, the Pit Viper's gripper tore the insulating foam into manageable pieces and deposited them in a nearby waste box, along with pieces of absorbent used to soak up water generated by the water jet. The “Pit Viper” performed wall grinding and debris scraping, scooping, and removal tasks on the final day. The entire activity was completed without personnel entry to the pit area during cleanup activities. The deployment was free of any significant issues, much of which can be attributed to an exceptional team and the realistic practice experience.



Fig. 1. Pit Viper Deployed at Tank 241-C-104

A deployment summary report is being prepared to document the lessons learned from the first deployment and serve as the basis for determining future use. The early indications support continued use of the system.

### **Single-Shell Tank Retrieval Technology**

The Hanford Federal Facility Agreement and Consent Order, commonly known as the Tri-Party Agreement (TPA), because it is an agreement between three key parties, the State of Washington Department of Ecology (Ecology), U. S. Environmental Protection Agency (EPA), and DOE. The TPA primarily governs the Hanford Site's waste storage, treatment, and disposal activities (3) and provides cleanup roles, responsibilities, requirements, and schedules.

During FY2000 and 2001, new near-term milestones for SST retrieval and closure were developed and incorporated into the TPA. The intent of the milestones was to re-focus the early tank retrieval activities on risk reduction and build a knowledge base of improved retrieval approaches through demonstration to support decisions on the balance of mission. Additionally, the new milestones emphasized reducing the risk to human health and the environment; scheduling negotiations over shorter, five-year intervals to use data and experience gained in the preceding years; using the Retrieval Performance Evaluation (RPE) Methodology; and integrating leak detection, mitigation, and monitoring approaches into planned retrieval demonstrations.

The ideal goal of any waste retrieval effort is 100% of the waste retrieved with no leak loss to the environment. However, achieving that goal is highly uncertain given the condition/integrity of the tank(s); physical characteristics of the waste; and the limitations of any selected waste retrieval system (4). This uncertainty dictates that a design and operating approach be defined for retrieval and leak detection, mitigation, and monitoring system requirements in the context of risk and the ideal goal stated above. In general, all the technologies seek to achieve higher retrieval efficiencies by matching the retrieval approach to the waste by deploying the least complex system capable of removing the waste. Additionally, the systems all are designed to carefully control the free liquid inventory in the tank at any given time. This is important since the free liquid is most likely to be lost in the event of a tank leak during retrieval. The technologies also seek to assure that no more dilution than necessary is added during retrieval to ensure the most effective use of existing DST space.

RPP is pursuing the following three SST retrieval technology demonstrations<sup>1</sup>, each with a different technical approach:

- Saltcake Retrieval Demonstration (tank 241-S-112) - Low-Volume Density Gradient (LVDG),
- Sludge Retrieval Demonstration (tank 241-C-104), and
- Saltcake/Sludge Retrieval Demonstration (tank 241-S-102).

The demonstration tanks have been selected to define a representative set of tank retrievals to support planning for the balance of mission. Three generic tank groups: saltcake, sludge, and saltcake/sludge were identified. Hanford Site 200 East and 200 West Area geologies differ, so tanks were selected in each. The demonstrations occur in tank farms with and without previous leakage to the environment. An additional consideration in selecting these tanks was their proximity to the DST system. Using SSTs near the DST system requires less new transfer piping and supporting infrastructure. The three tanks (241-S-102, 241-S-112, and 241-U-107) selected are currently designated as “sound.” These tanks also contain significant inventories of waste relevant to environmental and worker risk<sup>2</sup> to safer storage in the DST system (5).

All three demonstrations/approaches are designed to improve upon the past-practice sluicing approach, most recently deployed at Hanford in tank 241-C-106 (C-106), by achieving higher retrieval efficiencies; reducing potential for leaks from the tanks and the transfer system during retrieval; minimizing the volume received (e.g., reducing the water addition during retrieval) in the DST system; and reducing the deployment and operational costs.

### **Saltcake Retrieval Demonstration**

The saltcake waste demonstration on tank 241-S-112 (S-112) will use a Low-Volume Density Gradient (LVDG) approach, which focuses on where the majority of high-risk tank contents are soluble. This approach, also known as “saltcake dissolution” carefully matches the addition of water added via spray nozzles to dissolve the saltcake to the volume and concentration of the resulting salt solution being pumped from the tank. Once the salt solution is pumped from the tank, water jets will be used to slurry the heel toward the centrally located pump. This approach is the cheapest and least complex of the three demonstration technologies. However, it is likely to be suitable only for tanks where the majority of the volume consists of saltcake and the high-risk contents are soluble. It is important to note that the S/SX Waste Management Area where tank S-112 is located has been extensively characterized to establish the nature and extent of past leakage in the tank farm and to determine contaminant mobility. The LVDG approach is the subject of “proof-of-concept” testing in tank 241-U-107 (U-107) discussed later in this paper.

ORP is planning to conduct this demonstration concurrently with interim stabilization. Interim stabilization is an ongoing effort to remove the pumpable liquids from the SSTs, thereby, reducing the potential impact of a leak to the environment. If successful, this will complete the retrieval more than a year earlier than the TPA milestone commitment. Current activities include preliminary engineering, evaluating the tank characterization data, and working with Ecology to obtain approval of the functions and requirements.

### **Sludge Retrieval Demonstration**

The sludge retrieval demonstration on tank 241-C-104 (C-104) is designed to demonstrate waste retrieval in tanks that contain largely insoluble sludge and/or heels. This demonstration will employ a technique called “confined sluicing” also known as “localized addition and retrieval of liquids and waste”. This approach will use a pneumatic assisted vacuum retrieval and conveyance system to mobilize waste in the vicinity of the suction head system. The tank C-104 Mobile Retrieval System (MRS) uses a mast capable of rotating, elevating, and extending inside the tank to position the intake of the vacuum system. An in-tank vehicle will be used to move waste to the conveyance system intake (6). The conveyance system will transport the waste to the tank surface where a booster pump will enable transfer to the DST system. This technology is expected to be the most complex of the three retrieval technologies and the most costly to deploy. However, it is also the one most likely to be suitable for all waste types, have the smallest volume of free liquid in the tank during retrieval, and the least water addition for transfer to the DST system.

This demonstration is undergoing preliminary engineering, preparing for cold demonstration of the MRS in summer 2002, and pursuing regulatory approval. An initial demonstration of the full-scale system at the vendor facility is scheduled in April 2002. Extensive follow-on testing will be performed at the Hanford Site by the end of calendar year 2002.

### **Saltcake/Sludge Retrieval Demonstration**

The saltcake/sludge retrieval demonstration on tank 241-S-102 (S-102) is designed to demonstrate waste retrieval from tanks that are largely saltcake and expected to contain or produce significant sludge heels. This technology is a bridge between the relatively unobtrusive dissolution approach demonstrated in tank S-112 and the comparatively complex mechanical approach demonstrated in tank C-104. The tank S-102 retrieval demonstration is testing power fluidic mixing and pumping systems similar to those used at the Oak Ridge National Laboratory (ORNL) Gunite and Associated Tanks (GAAT) cleanup project (7). A cold testing program initiated in FY2001 and continuing in FY2002 has been evaluating systems capable of mobilizing and pumping the waste. The testing is focused on demonstrating the suitability of systems capable of deployment through both 12-inch and 24-inch risers. Unfortunately, there are comparatively few large risers available in the SSTs. However, a single large system could prove to be more effective than multiple smaller systems and may require lower volumes of liquid addition to support retrieval. Additionally, the Russian Pulsating Mixer Pump is being evaluated to determine its suitability for tank S-102 and other tanks at Hanford.

Current activities include conceptual engineering, development of functions and requirements, and evaluation of the ongoing test results. The plan is to complete the Functions and Requirements document by August 2002 to allow submittal for regulatory review by the end of FY2002 and complete retrieval of tank S-102 by the end of July 2006 (8).

### **Saltcake Dissolution Proof-of-Concept Demonstration**

The Saltcake Dissolution Proof-of-Concept demonstration on tank 241-U-107 (U-107) is designed to determine the suitability of dissolution techniques for waste retrieval that will make the retrieval operations in tank S-112 more efficient, effective, and less risky. The test objectives are:

- Reduce inventory of waste stored in tank U-107 (above interim stabilization projections),
- Reduce the technical risk, cost, and uncertainty prior to full-scale deployment of the approach in tank S-112,
- Improve ability to predict waste volume and contaminant removal rates, and
- Continue to evaluate Leak Detection, Mitigation, and Monitoring (LDMM) concepts including in-tank instrumentation, process instrumentation, and the Topographical Mapping System (9).



The demonstration is closely coordinated with the interim stabilization of tank U-107. This coordination enabled the demonstration to occur earlier and for lower cost than would have been expected for an independent effort. Additionally, the use of the skilled interim stabilization team makes the best use of experienced and knowledgeable staff. The demonstration is using equipment installed by the interim stabilization project, including pumping and transfer systems. Equipment added for the test includes two riser assemblies outfitted with sprinkler nozzles, additional process instrumentation, and the Topographical Mapping System (TMS). This is the first in-tank deployment of the TMS at Hanford and follows several deployments at the Oak Ridge Reservation in 1997 (10, 11).



Fig. 2. Saltcake Dissolution Proof-of-Concept Demonstration Equipment Installation

Before the demonstration activities are initiated, the liquid level in the tank must be pumped to well below the saltcake level. This is to provide a drained volume within the saltcake matrix to enhance mass transfer to the dissolution water. The plan is to add water using the sprinkler nozzles in a series of carefully controlled additions. Samples will be taken to determine the resulting salt solution or “brine” produced during the additions. The TMS will be used to measure the waste surface at key points between water additions. This is a valuable data set to obtain as the process is expected to create an irregular waste surface as the saltcake dissolves relative to the sprinkler nozzles’ area of influence. The nozzles will be evaluated for their effectiveness in dissolving the saltcake. The test is designed to remove approximately 114 m<sup>3</sup> (30,000 gal) of saltcake from U-107 (9).

Currently used techniques measure the tank waste level at a single point, which cannot provide accurate volume measurements of a tank with an irregular waste surface. The TMS uses a laser-based technique to develop a 2-dimensional digital map of the waste surface. The data is used to develop a volume estimate for the waste in the tank. The TMS is capable of mapping a grid spaced as small as 0.25 inches apart, although the time to complete a map increases with resolution. Recently, the tank S-112 retrieval demonstration was successful in securing additional DOE/OST funding to fabricate and deploy a second-generation TMS.

The tank U-107 demonstration equipment was installed and ready for operation in September 2001. However, difficulties with pre-existing transfer line plugging have delayed the demonstration. The demonstration remains a priority for RPP and will be initiated as soon as possible.

### **Leak Detection, Mitigation, and Monitoring**

Leak Detection, Mitigation, and Monitoring (LDMM) is an integral part of the three retrieval demonstrations. Current methods for detecting leaks outside the tanks have consisted primarily of lowering equipment into boreholes in the soil around the tanks. Radiation surveys can detect gamma-emitting radioactive contaminants in the soil, and neutron probes can detect moisture. The drawback of these methods is contamination in the soil has to be within a few feet of the boreholes for reliable detection.

During FY2001, RPP identified and selected LDMM technologies and approaches that will support the three SST retrieval demonstrations. In-tank instrumentation in the tank farms relies on a consistent waste level across the entire tank. Limitations associated with ex-tank spectral gamma ray and moisture logging in dry wells compromises leak detection capabilities.

The FY2001 effort focused on conducting demonstrations of LDMM techniques at the 105-A Mock Tank Leak Site in the 200 East Area at Hanford during the summer of 2001. The 105-A Mock Tank Leak Site was designed specifically to simulate tank leaks. The facility includes a Mock Tank that is two-thirds the diameter of the typical Hanford SST 15.2 meters (50 feet) vs. 22.9 meters (75 feet). The Mock Tank is open at the top, with half its 6.1 meters (20 feet) height buried 2.7 meters (9 feet) in the ground. The facility also includes an 18.9 m<sup>3</sup> (5000 gal) storage tank and a system of PVC (polyvinyl chloride) pipes to distribute a simulated tank leak liquid at various locations along the bottom or sides of the tank. The liquid used was an environmentally friendly, non-radioactive sodium thiosulfate solution, similar in density, viscosity, ionic strength, and electrical conductivity to tank waste. The liquid has been safely used as a simulated tank waste solution in other Hanford vadose zone transport studies.



Fig. 3. LDMM Demonstrations at 105-A Mock Tank Leak Site

RPP assessed the test data resulting from the FY2001 effort at the end of January 2002 to down-select to the top two or three leak detection technologies. Follow-on work will include more rigorous performance testing in accordance with EPA requirements or other suitable protocols to demonstrate the technologies' ability to work as part of the retrieval system with specific emphasis on determining the probability of detection and probability of false alarms.

Four basic types of ex-tank leak-detection methods were also evaluated:

- *Electrical Methods:* Three methods - Electrical Resistance Tomography (ERT), High Resolution Resistivity, and Electromagnetic Impedance. Two methods charge the ground with electricity and use detectors to sense how the current moves through the soil. Current passes through moisture more quickly. A third method operates much like a metal detector, using a coil of wire to create a magnetic field that interacts with the leak.
- *Tracer Gas Method:* This technology is also called Partitioning Interwell Tracer Tests. This method involves pumping air into a borehole and through the soil under the tank. Gas tracers that dissolve in waste are injected into the air stream, extracted at a borehole on the other side of the tank, and analyzed using gas chromatography. This method is a proven technology and has been used in the environmental remediation industry to detect and measure soil contamination.

- *Borehole Seismic Method:* To make an image of a leak, this method uses sound reflecting off the target-in this case the high-density, simulated tank waste. The method also provides information on site geology, including soil types and soil-layering features.
- *Radar Method:* This method is similar to the borehole seismic method, except that radio waves are used to produce an image of the leak.

In addition to the demonstrations discussed above, TFA sponsored a leak mitigation approach using hydroxyapatite. Hydroxyapatite, or “apatite,” could be used in Hanford soils to form a reactive barrier, or “zone”, that would sequester technetium and uranium in-situ. This could be used to prevent migration of leaks into the soil during retrieval.

Apatite was formed in Hanford soil samples using a calcium citrate and sodium phosphate solution. In 2001, testing of apatite reactive zone technology supported of Hanford's SST retrieval efforts. The work focused on:

- Characterizing the formation of apatite in Hanford soils,
- Evaluating the ability of apatite to absorb technetium and uranium; including the extent of irreversibility in solution, and
- Evaluating the ability of apatite to absorb technetium and uranium, and the extent of irreversibility, under in situ soil conditions using laboratory scale column experiments.

The apatite formation was evaluated using X-Ray Diffraction analyses. Treated and untreated soils were tested in batch equilibrium and column experiments using technetium and uranium in synthetic Hanford groundwater and tank waste simulants. The bench-scale tests show promise toward using apatite to mitigate leaks. Additional testing will focus on bench- and field-scale tests are needed to address issues associated with deploying the approach.

## **Cold Test Facility**

RPP is constructing a Cold Test Facility, which will be used to develop and demonstrate a variety of equipment used in the SSTs and DSTs and provide an opportunity to practice in a non-hazardous, non-radioactive waste environment prior to implementation in the field.

The facility will include a full-scale tank capable of handling waste simulants. The tank is 75 feet high and can hold simulants at depths up to 25 feet. A steel superstructure spanning the tank will provide two platforms. The lower platform is fixed at a height that simulates the shorter 530,000-gallon SST configuration. The upper platform simulates the 1,160,000-gallon DST configuration. The Facility is capable of storing simulants for re-use. Simulant components include silica sand, kaolin and/or bentonite clays, sodium bicarbonate, sodium nitrate, and water (12). These components allow the simulation of supernatant, sludge and saltcake wastes, as well as, combinations. The Cold Test Facility will also include two support buildings and a one-acre laydown area.

Construction of the Cold Test Facility Construction was begun in November 2001. The facility will be complete and ready for occupancy by July 2002. Projected near term use of the facility is largely focused on the SST retrieval demonstrations described earlier.



Fig. 4. Hanford Cold Test Facility Construction and Sketch

## SUMMARY

The Hanford tank cleanup scale and diversity is a formidable challenge. ORP recognizes the need to aggressively pursue strategies that are protective of human health and the environment while reducing the cost of tens of billions of dollars and several decades to complete the cleanup. In fact, due to these budget and time constraints ORP believes that it is essential that technologies be developed that will complete the cleanup earlier, reduce risk to human health, help prevent additional environmental insult, and reduce costs.

RPP is actively developing, evaluating, and deploying storage and retrieval technologies, such as:

- The “Pit Viper” robotic arm mounted to a backhoe to improve access to tank pits while reducing the radiation dose to the worker.
- Single-Shell Tank Retrieval Demonstrations in tank 241-S-112, 241-C-104, and 241-S-102 that focuses on technologies that may potentially reduce the amount of water necessary to retrieve the non-liquid waste (e.g., sludge, saltcake) in the tanks.
- Saltcake Dissolution Proof-of-Concept Demonstration which will use equipment currently used in the interim stabilization of liquids in the tanks, as well as the Topographical Mapping System to measure the waste surface at key points.
- Leak Detection, Mitigation, and Monitoring methods to detect leaks into the soil during retrieval.
- Constructing a Cold Test Facility to allow demonstration of equipment and an opportunity to practice in a non-hazardous waste environment prior to implementation in the field.

Tangible progress is being made at Hanford where ORP, OST, and their partners are developing, demonstrating, and deploying technologies for remote maintenance in tank farm pits, SST

retrieval, and LDMM. These activities are now integrated to support new TPA milestones; include investments in facilities to continue development into the future, and to make significant near-term progress in cost and risk reduction.

## FOOTNOTES

<sup>1</sup> The TPA requires only two retrieval demonstrations

<sup>2</sup> Reference 8 describes the use of relative near-term (worker) and long-term (future site user) risk posed by the waste as a key criterion in sequencing SSTs for retrieval.

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