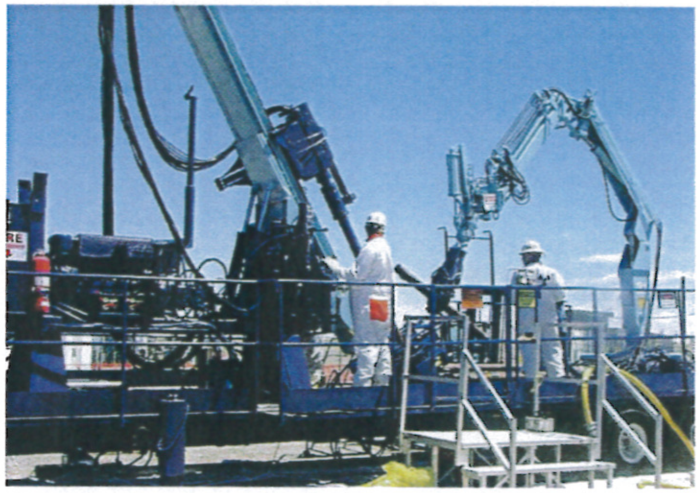
Overview

Tank Farms Vadose Zone Project

The WRPS Tank Farms Vadose Zone Project was established to understand the contamination in the soil beneath Hanford's underground waste storage tanks so action can be taken to protect public health and the environment. The storage tanks hold 53 million gallons of radioactive and chemical waste. The soil contamination is the result of earlier leaks from as many as 67 older single-shell tanks, as well as discharges to the soil from past site operations. The project focuses on contaminants in the vadose zone, which is the area of soil between the ground's surface and the water table. Information gained from the project will be integrated with data from other groundwater/vadose projects at the site, providing greater understanding of the site's surface contamination.



Slant borehole technology allows us to obtain soil characterization information while minimizing waste generation and protecting our workers from potential exposure to contaminants.

Technological Resources

WRPS is using advanced technologies, such as the Slant Borehole system, the Direct Push technique, and Subsurface Geophysical Exploration, to understand the nature and extent of contaminants in the soil beneath and around the tanks. With these and other innovative approaches, we can investigate areas that are difficult to reach with conventional techniques, and we can accurately characterize the contaminants and their locations and migration in the environment. The information is essential to develop strategies that will monitor and mitigate any risks to human and ecological health.

Slant Borehole

Hanford's 149 single-shell waste storage tanks are grouped into 18 "tank farms" and are buried more than ten feet underground. As such, the most difficult locations to investigate are underneath the tanks. The slant borehole is a safe technique that has been successfully tested and deployed at Hanford. It uses a pile driver (40,000 lbs of force) to drive what is known as a dual string casing into the ground at a 30 degree angle. No soil cuttings are generated because brute force displaces the soil away from the drive tip and the casing moves down the hole with the drive tip. This technique minimizes waste and protects our workers from potential exposure to contaminants.

The Hydraulic Hammer is a light weight, mobile tool allowing us to characterize soil in our tank farms that has otherwise been beyond our reach.

Direct Push

Another major advancement is in the area of direct push technology. Because of the contamination in the soil, boreholes are very expensive to install. A new technique, using a hydraulic hammer, was developed and deployed, allowing us to get our work done faster and at less cost than expected. The hammer is light, agile and has a specialized head which allows it to bore past rock and compacted soil. This gives the device the ability to reach greater depths and improve our ability to characterize soil contamination. Because it is mounted on a light weight mobile backhoe, it has the ability to reach more locations inside tank farms than traditional drilling equipment.

Surface Geophysical Exploration

We are using an advanced geophysical technique to track and mitigate tank waste leaks into the surrounding soil. Surface Geophysical Exploration uses the electrical properties of the soil to map potential contamination plumes. This is accomplished by inserting metal probes (electrodes) in the soil in areas where a contamination plume is suspected and connecting the probes to a central computerized data collection system. A variation of the technique uses metal casings of existing wells as electrodes. Electric current is then applied to all combinations of probes and well casings, and the resistance of the soil between each electrode is measured. Because soil moistened with waste conducts electrical current better than dry uncontaminated soil, a plume can be identified and its boundaries mapped.

Preventing the Spread of Contamination

While we have been characterizing the vadose zone, a great deal of work has been completed to prevent contamination from spreading further in the soil and reaching groundwater.

- All water lines going into the tank farms have been tested and either cut and capped outside of the farms, or repaired so they do not leak.
- Berms and gutters were constructed to divert rain water, snow melt, and accidental water discharges away from the tank farms.
- Approximately 800 boreholes, or drywells, have been drilled inside the tank farms so instruments can be inserted to detect leaks and measure moisture content of the soil, have been recapped, eliminating a potential pathway for liquids to reach the vadose zone.

Interim Barrier

A temporary barrier was installed in FY08 over one of Hanford's known tank leaks to demonstrate its effectiveness in preventing rain and snow from reaching the soil around the tanks and driving contamination further into the vadose zone. The barrier was made of polyurea and polyurethane, similar to the protective liners put into truck beds to prevent leakage and corrosion.

Pursuing Additional Technologies

Remediation of the contamination beneath Hanford's waste tanks will be one of the greatest challenges facing the site. New technologies are continually being explored that will provide a better understanding of the nature of the contamination, the extent to which it has spread and how best to deal with it. The program's goal is to reach final tank farm closure, including the remediation of the soil and infrastructure that meet the terms of the Tri-Party Agreement.

All of the progress is being coordinated with the Washington State Department of Ecology. WRPS is fully integrating its work with the Groundwater and Soil Remediation technical staff at the Department of Energy's Richland Operations Office and with other Hanford contractors to optimize the data collection and decision-making process across the Hanford Site.

Earthen berms have been placed around single-shell tank farms to prevent rain and snow melt from flooding the farms and driving soil contaminants deeper into the vadose zone.

Surface geophysical exploration uses the electrical properties of soil and moisture to detect and map contamination plumes in the soil.

A temporary barrier was installed in T Farm in FY08. Workers are shown applying the polyurea and polyurethane, (insert). Artist rendering, (background), shows finished barrier.

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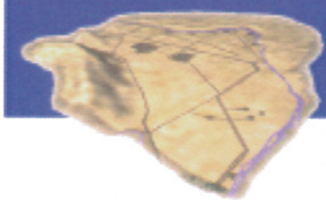
Overview



Vadose Zone Accomplishments

The Washington River Protections Solutions Vadose Zone Program is increasing our understanding of contaminants in the soil around Hanford's underground radioactive waste storage tanks so action can be taken to protect public health and the environment.

The vadose zone is the area of soil between the ground's surface and the water table. Much of the vadose zone around and below Hanford's tanks is contaminated with radioactive and chemical material that has accumulated over the past 63 years. The contaminants include up to a million gallons of radioactive and chemical material that leaked from as many as 67 of the tanks. There is also contamination from intentional discharges of liquids to ditches and cribs. Some of the contaminants have already reached the water table.

Because water is a force that can drive contaminants to the water table, it is important to minimize and control rain and snow runoff, as well as surface flooding and leaks from water lines. Berms, curbs, culverts and gutters have been installed around all 12 single-shell tank farms to prevent the flow of surface water into the farms. We have also leak-tested all water lines serving the single-shell tank farms, repaired or sealed leaking water lines, and installed waterproof caps on 998 drywells.

In addition, numerous other projects have been conducted since the beginning of the Hanford cleanup program to address the contaminant issues in the vadose zone. The work has encompassed:

- Sampling and testing of the forces that cause waste to move in the soil
- Development and deployment of technologies to detect and monitor contaminants in the soil
- Installation of numerous boreholes in the soil to detect movement of radioactive materials such as Cesium 137 and technetium 99
- Publication of more than a dozen major reports on the studies and their findings
- Public release of more than 180 documents dealing with vadose zone contamination beneath Hanford's tank farms
- Control of water discharges to the ground.

With each study and activity we are expanding the body of knowledge about subsurface conditions in the tank farms. The work is significantly improving our understanding of the contaminant waste plumes, their content, and their migration through the vadose zone.

Curbing has been installed around some of Hanford's tank farms to prevent runoff from reaching the farms and driving contaminants down to the water table.

Earthen berms have been installed in several tank farms to redirect runoff away from the farms and prevent the runoff from driving soil contaminants down to the water table.

Another means of preventing surface water runoff from reaching the soil around tank farms has been the installation of culverts to redirect water away from the farms.

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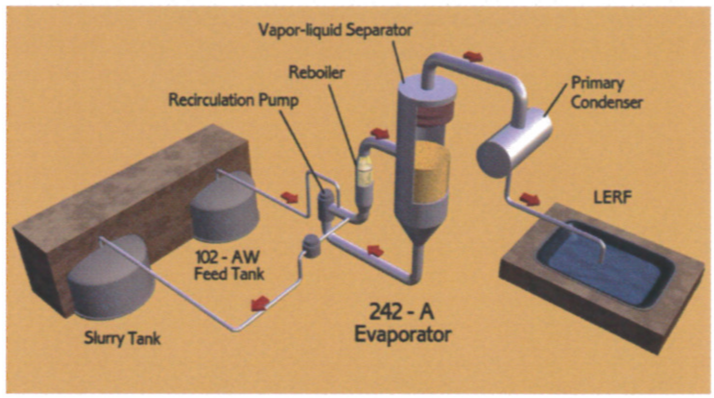
Overview

242-A Evaporator

242-A Evaporator and Surrounding Area



Evaporator Process Diagram

242-A Cold Crew

WRPS operates the 242-A Evaporator in the 200 East Area of the Hanford Site. The evaporator is critical to the safe management of Hanford's tank waste. It began operating in 1977 to reduce the volume of waste stored in our underground tanks By removing water from the waste WRPS is able to make additional storage space available for continued retrieval of waste from Hanford's aging 149 single-shell tanks.

Prior to processing waste through the Evaporator, the waste is extensively analyzed to determine its key constituents. This information is used to determine how the waste will behave both during and after the evaporation process, and to determine how much water can be safely removed from the waste.

If acceptable for processing, the waste is pumped into the evaporator from nearby double-shell tanks via double-walled underground transfer lines. It goes into a sealed vessel where atmospheric pressure is reduced and steam heat is applied, boiling the waste at only 125 degrees F., much lower than it would under normal pressure. When the waste reaches a designated thickness, called specific gravity, the waste is transferred to a double-shell tank for storage.

The evaporated water is captured, condensed, filtered, sampled and sent to the nearby Liquid Effluent Retention Facility, which further treats the liquid before disposal. The evaporator is able to achieve a significant reduction in waste volume, which increases available tank storage space. This reduction in volume helps avoid the high cost of building and eventually disposing of new storage tanks. In 2007, evaporator campaigns reduced the volume of tank waste by 1.2 million gallons.

The 242-A Evaporator is the only operating nuclear facility at Hanford. It operates under strict environmental regulations, stringent operational controls, and requires extensive maintenance and operator training to maintain the facility in a fully operable condition. In years where waste processing campaigns are not required to meet space management objectives, an evaporator "cold run" campaign is conducted using water instead of waste to ensure continued facility and systems operability, and to train and maintain the proficiency of operators.

In 1987 engineering and design studies were initiated to extend the operating life of the evaporator. In 1989 a series of additional changes were made to address environmental protection issues. Following facility modifications and upgrades the 242-A Evaporator was restarted in 1994. Since 1994 additional modifications and upgrades have been completed to extend the operating life of the facility. Recent upgrades, which include replacing the ventilation system and upgrading the monitoring and control system, will extend the operating life of the facility to 2034.

Since it began operating in 1977, the Evaporator has reduced the total volume of waste in Hanford's tanks by 66 million gallons, helping avoid the high cost of building new waste storage tanks.

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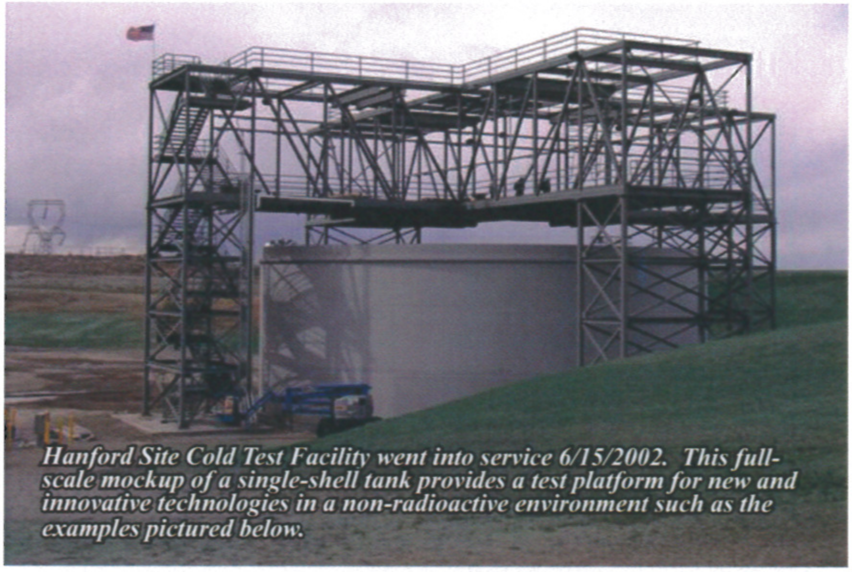
Overview

Cold Test Facility

The Hanford Cold Test Facility (CTF) is our test site for tank waste retrieval technologies. Hanford's underground radioactive and chemical waste storage tanks present unique challenges as well as unique hazards to our workforce. To overcome issues we use the CTF to test hardware and train personnel who will operate the technologies. It is a non-radioactive environment that simulates tank waste conditions to determine whether a particular piece of hardware will function as intended without compromising the safety of our workers.



Hanford Site Cold Test Facility went into service 6/15/2002. This full-scale mockup of a single-shell tank provides a test platform for new and innovative technologies in a non-radioactive environment such as the examples pictured below.

WRSP has used the CTF to test such innovative retrieval technologies as vacuum retrieval. The Hanford-developed vacuum technology uses small amounts of water under high pressure to mobilize the waste and vacuum it to the surface where it can be transferred to double-shell tanks for safe storage. This compares to traditional sluicing techniques which use large amounts of water under relatively low pressure to mobilize the waste so it can be pumped. Sluicing is effective in tanks that are sound and contain waste that dissolves or breaks up readily. However, in tanks with a history of leaking, vacuum retrieval is ideal because the water can be removed as quickly as it is introduced, thus minimizing the potential environmental impact.

Vacuum Retrieval Technology is tested using artificial simulant waste at the Cold Test Facility

Another technology tested at the CTF is the Salt Mantis, a device that can crawl across the bottom of the tank and use a stream of high pressure, low volume water to break up and mobilize hardened waste. The Salt Mantis uses a sophisticated nozzle system that shoots up to six gallons of water per minute at a pressure of up to 35,000 pounds per square inch. The device is manufactured by TMR Incorporated in Lakewood, Colorado. By comparison, a fire hose can shoot a stream of water at 125 pounds pressure at a flow rate of 150 to 250 gallons per minute. The Salt Mantis has been used successful in retrieving waste from tank S-112 and its performance has more than exceeded expectations.

A third technology tested at the CTF is the Sand Mantis, developed to combine the best traits of the Salt Mantis and vacuum retrieval into a single unit. Like the Salt Mantis, the Sand Mantis is a rugged, remotely operated device with the ability to move around inside a tank, but instead of using water to wash the waste to the pump, it takes the pump to the waste. An added feature is the use of a pump with no moving parts, making the Sand Mantis simple to operate and highly reliable.

Adjoining the CTF is the Joint Briefing Center where the Office of River Protection and WRSP managers can provide detailed information about tank waste management and retrieval operations to Hanford Site visitors. Technological advances and innovations such as the CTF are leading the way in nuclear cleanup operations.

Workers examine the Sand Mantis during testing

The Sand Mantis can removes 3.5 cubic feet of simulant waste in 10 minutes

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Overview

Surface Geophysical Exploration

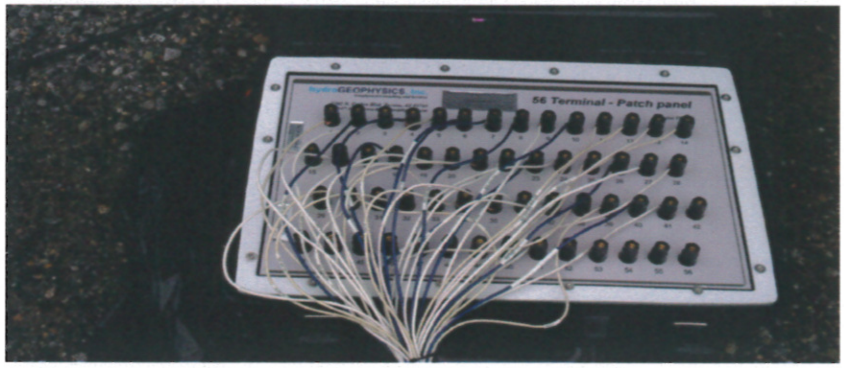
Surface Geophysical Exploration is helping to improve our understanding of the nature and extent of soil contamination beneath Hanford's underground radioactive waste storage tanks. Our goal is to understand the contamination so we can take action to protect human health and the environment.

As many as 67 of Hanford's older, single-shell tanks have leaked as much as a million gallons of liquid waste to the surrounding soil. The waste has moved through the soil and some has reached the ground water table. Before remediation work can begin we must understand the nature and extent of the contamination so we know where to concentrate our efforts and make the best use of taxpayer dollars. Soil contamination also exists outside tank farms in areas used as liquid waste discharge sites. These areas, too, must be characterized and cleaned up if we are to reduce the risk posed by these contaminants..

Surface Geophysical Exploration, (SGE) is so named because it doesn't require excavation or drilling of holes in the ground, instead it uses the electrical properties of the soil to map potential contamination plumes. Metal probes (electrodes) are inserted in the soil in areas where a contaminant plume is suspected. The probes are connected to a central data collection system. A variation of the technique uses metal casings of existing wells as electrodes alone, and in connection with the probe. Electric current is applied, sequentially to all combinations of probes and well casings, and the resistance of the soil between each electrode is measured. A plume can be identified and its boundaries mapped because soil impacted by waste conducts electrical current better than dry or uncontaminated soil.

SGE is an important addition to our "tool box" of subsurface characterization technologies. Waste is minimized because nothing is brought to the surface as with conventional investigation techniques. Furthermore, since the work is performed on the surface our workers are protected from exposure to subsurface contaminants.

SGE provides a means to precisely target sampling for physical and chemical properties of the vadose zone. As a result, we have expanded our knowledge of the extent of the contamination. With additional work it may be possible to use SGE to learn more about the concentration and distribution of contaminants in the vadose zone. Studies are being conducted to understand the impact of interference from underground piping and other structures buried in the soil. The full impact of Hanford's layered soil formations on SGE interpretations is not fully known. Work in these areas is also continuing.



Electrodes are connected to a central terminal from which waste plume data can be collected.

An array of electrodes is driven into the soil and connected to a central terminal where electricity is applied to measure soil resistance. The data are used to map the location, size and configuration of contaminant plumes in the vadose zone around the tanks.

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Overview

Modified Sluicing Retrieval

A single-shell tank (SST) waste retrieval method, known as "past practice sluicing," was used at the Hanford Site through the late 1990s. Past practice sluicing used large volumes of high-pressure water to dislodge, dissolve and suspend solid wastes for transfer to the safer double-shell tank (DST) system. Increasing concerns over the leak integrity of the SSTs, combined with limited DST receiver tank space, required alternate retrieval methods to be reviewed. Demonstration of alternate retrieval methods is under the M-45 series of milestones in the Tri-Party Agreement (TPA), which governs Hanford Cleanup.

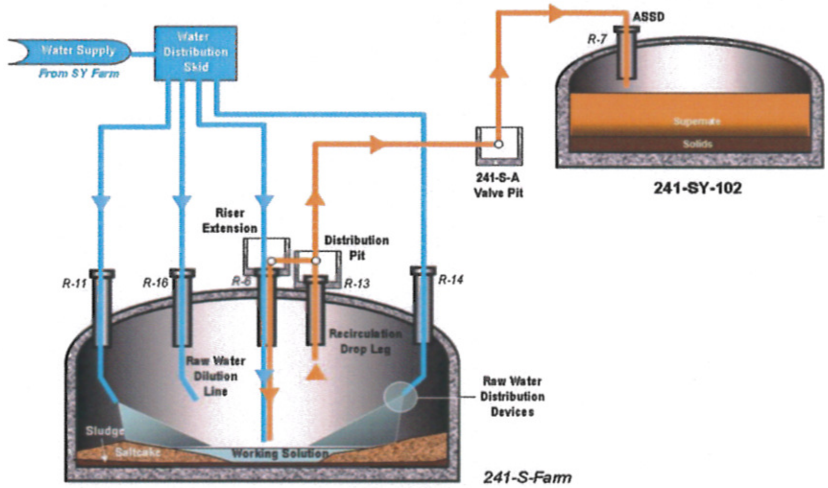
Modified sluicing involves additions of low volumes of liquids through a nozzel with concurrent removal at a higher rate by the retrieval pump. The modified sluicing system is capable of using raw water or recycled liquid waste (to conserve DST space). In cases where the solid waste is difficult to remove, an acid dissolution process can be used to facilitate retrieval of the waste.

Modified sluicing was first demonstrated in tank C-106 following retrieval of 187,000 gallons of waste where past practice sluicing had been used. Additional waste retrieval was required to resolve high-heat safety issues caused by the build-up of heat from the decay of Strontium-90 in the remaining 36,000 gallons of waste remained.

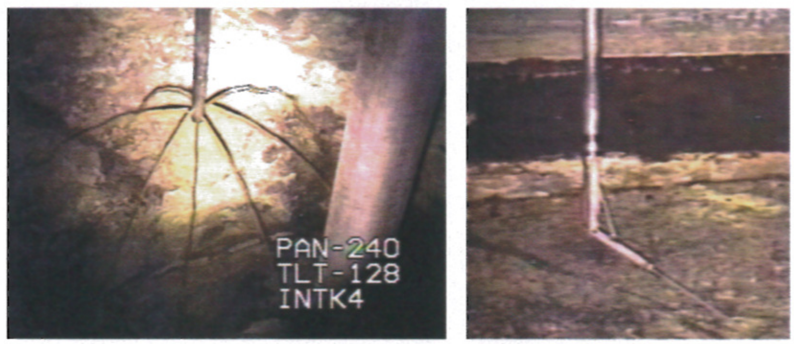
Modified sluicing of tank C-106 was initiated in April 2003 and was completed in December 2003. An oxalic acid dissolution process was incorporated to dissolve the solid waste heel and improve retrieval efficiency. Approximately 99% of the waste was removed.

When the limits of this technology had been reached approximately 370 cubic feet examined. This includes residual waste on the tank bottom, in abandoned in-tank equipment, and on tank wall stiffener rings. The TPA established a retrieval goal of no more than 360 cubic feet of residual waste or limit of retrieval method (whichever is less). Based on cost and risk assessments, additional waste retrieval would be overly costly and would not significantly reduce risk.

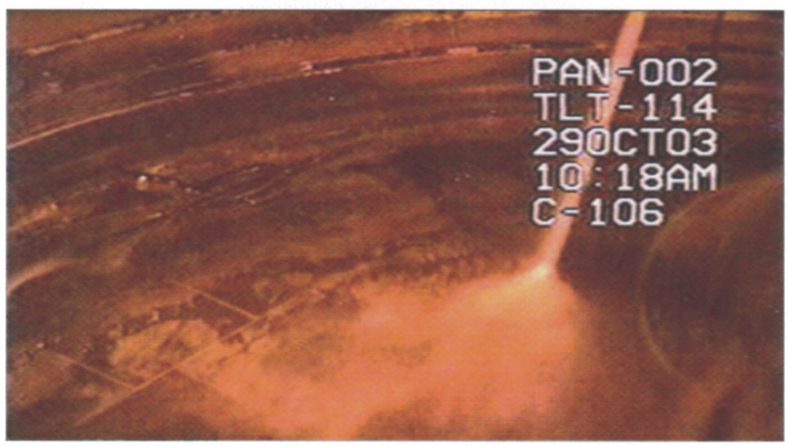
Lessons learned from the modified sluicing retrieval of tank C-106 have been incorporated into other ongoing retrieval activities.



Modified sluicing system schematic



Raw water distribution device



Bottom of Tank C-106 after modified sluicing

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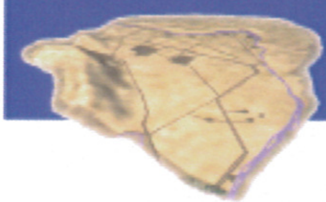
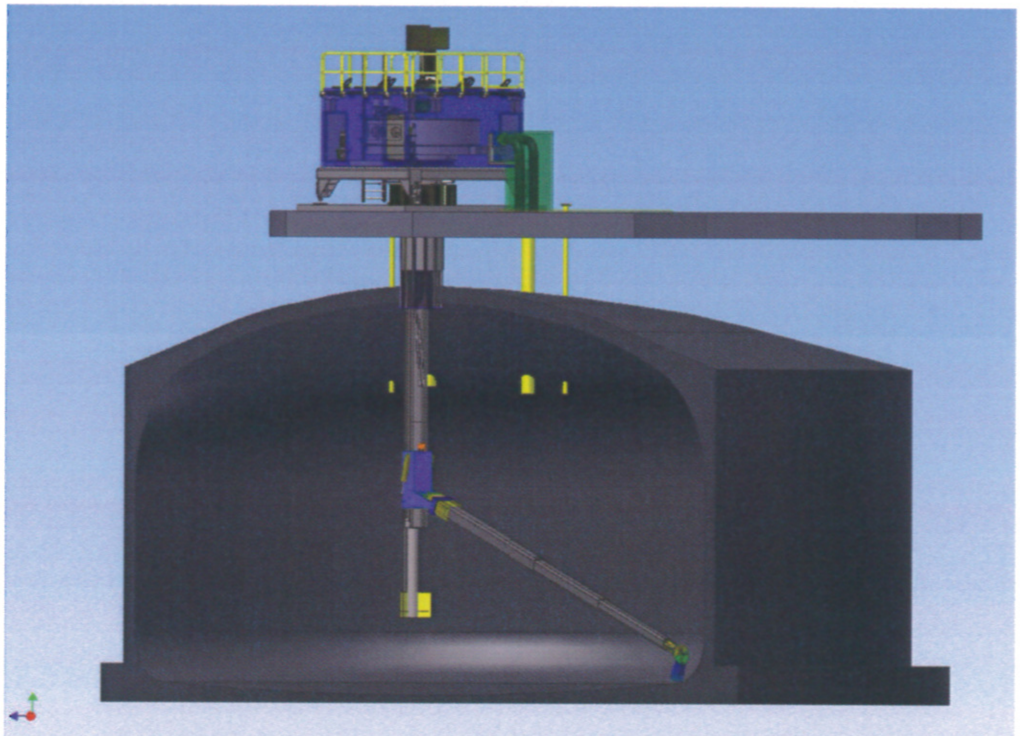


Robotic Arm

New Generation of Robotic Arm to Aid in Tank Waste Removal

A new generation of robotic arm offers the potential to increase the efficiency of waste removal from Hanford's single-shell tanks. This new retrieval system is referred to as the Mobile Arm Retrieval System (MARS). It includes the robotic arm as well as the ancillary equipment to transfer the tank waste from the aging single-shell tanks to newer and safer double-shell tanks.

The arm will be capable of a wide range of motion and will include a telescoping capability to enable it to reach all parts of a tank. The system will also include the capability to change out the working end of the arm to enable it to mobilize difficult waste forms such as salt cake, and sludges, as well as the hard heel that has built up at the bottom of some of the tanks.



Robotic arms have been studied in connection with tank cleanout several times in the past but the technology and deployment strategies were not sufficient to make them viable. Incorporating lesson learned and new technology innovations the options for effective tank waste retrieval have been significantly increased.

MARS is a technology development and deployment activity intended to improve on the past activities not only at Hanford but at other Department of Energy sites and produce a viable robotic arm retrieval system.

Part of the design challenge will be to make a large portion of the system transportable so it can be moved from one tank to another and make use of existing tank farm utilities, such as electrical and water systems. Design work is expected to be completed before the end of 2009, with fabrication and installation expected in 2010. The robotic arm will likely see its first deployment in a C-Farm tank. Development of new and innovative technologies to speed the retrieval of tank waste and make retrieval operations more efficient and cost effective is a cornerstone of Washington River Protection Solutions' goals to reduce the risk to the environment posed by the waste in Hanford's aging underground storage tanks.

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