Highlights
Environmental Management
Engineering and Technology
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Making a Difference

Since 1989, the Department of Energy's (DOE) Office of Environmental Management (EM) has faced many complex scientific and technical challenges – while cleaning up legacy wastes generated during the Cold War. To safely and efficiently accomplish its mission, DOE-EM has relied upon its Office of Engineering and Technology (OET) to reduce the risks associated with the cleanup activities through development of innovative technologies and sound scientific approaches to meet DOE's specific needs. As a result of these new technologies and approaches, DOE has made great progress that has included closure of significant sites, such as Fernald in Ohio and Rocky Flats in Colorado.

OET contributions have been critical to EM mission success. Two examples follow:

- Removal and treatment of 10,000 tons of uranium milling tailings from two 80-ft diameter silos at Fernald were accomplished after significant testing and engineering refinements provided by OET. These refinements enabled the closure of the Fernald Site 12 years ahead of schedule, at a cost savings of approximately $7.5 billion.
- Advanced chemical decontamination and foam encapsulation technologies supported by OET for treatment and disposal of more than 1,300 Rocky Flats' gloveboxes enabled the site to reach closure 50 years before and $30 billion less than originally estimated.

At DOE's Hanford and Savannah River sites, OET is currently working to reduce risks related to unique problems that involve treatment of high level waste, cleanup of contaminated groundwater, and deactivation and decommissioning of inactive facilities. To safely and efficiently meet DOE's cleanup goals and schedule, new approaches developed by an effective applied research and engineering program will be required. In 2008, the Office published its *Engineering and Technology Roadmap* and *Applied Research and Technology Development and Deployment Integrated Multi-Year Program Plan* (available on the web at www.em.doe.gov) to guide the program by identifying technology risks – those technical issues that could prevent project success – and developing 13 strategic initiatives to address these risks.

The articles contained herein provide highlights of a few of the current program activities.

To safely and efficiently meet DOE's cleanup goals, OET is implementing an effective applied research and engineering program with innovative new approaches.

Researchers demonstrate that an enhanced attenuation approach can lead to effective groundwater cleanup with reduced energy use and impact to the environment.

Edible Oil Treatment Leads to Enhanced Attenuation

A full-scale test at the Savannah River Site's T-Area, a former laboratory and semiworks operation contaminated by chlorinated solvents (cVOCs), is showing that a new approach, known as "enhanced attenuation," can lead to effective groundwater cleanup, while minimizing energy use and wetland damage that more aggressive remediation strategies sometimes incur, while also reducing life-cycle costs.

Enhanced attenuation is an innovative engineering and regulatory strategy that has recently been developed by EM-20 in collaboration with the Interstate Technology and Regulatory Council (ITRC). It can be applied at sites currently undergoing active remediation, where the site is altered so that self-sustaining, passive mechanisms – requiring no additional human action – can stabilize and shrink the contaminant plume. An important aspect is documenting that the action is effective, timely, and sustainable.

Beginning in the 1980s, the cVOC contamination has been treated by a combination of soil vapor extraction (SVE) and groundwater pump-and-treat. These actions removed the bulk of the cVOCs in the soil above the water table and contained the contaminant plume in the groundwater.

Supported by OET, SRNL tested an enhanced attenuation approach using edible oil ,which reduces cVOC concentrations in two ways: stimulating microbiological degradation processes and reducing their mobility by partitioning. In this strategy, pure oil is placed at the water table providing a shield against future inputs to groundwater and emulsified oil is injected in the contaminated groundwater to stimulate microbial degradation of the cVOCs.

For T-Area, enhanced attenuation proved to be a powerful "green solution" to transition from active treatment technologies using sustainable natural processes while minimizing energy use and wetland damage.

DOE Engages International and University Experience to Solve High-Risk Waste Processing Problems

OET is collaborating with NuVision Engineering and Florida International University (FIU) to address challenging waste cleanup problems, including testing and demonstrating a novel solution for plugged waste transfer lines, a high-risk problem at DOE high level waste (HLW) management sites such as Hanford and Savannah River. In the past, a number of pipelines have plugged during HLW transfers, resulting in potential safety issues, schedule delays, and increased costs.

For the last 13 years, EM has been working with the United Kingdom (U.K.) to transfer technologies and methodologies that have been successful in the U.K. into the U.S. cleanup program. The pipeline-unplugging technology is derived from a class of technologies known as Power Fluidics, which has been successfully used in Europe for 25 years and has been deployed for waste mixing, characterization, and retrieval at multiple DOE sites over the past 10 years.

The approach, developed by NuVision Engineering and demonstrated by FIU, relies on a 'wave-like' erosion mechanism in much the same way as the ocean erodes sand on beaches. Testing conducted in late 2007 demonstrated the efficacy of the approach on a 3-inch diameter pipeline of various lengths (285 ft, 621 ft, and 1797 ft) with representative blockages in a configuration comparable to that likely to be experienced in the field (number of elbows, elevation, etc.).

The innovative pipeline unplugging approach was demonstrated to have the following benefits:

- A short mobilization and demobilization time
- The ability to deliver chemical solvent to the blockage
- The ability to clear a section of the pipeline that has drained down below the elevation of the blockage
- Low pressures (<100 psi) that do not threaten pipeline integrity and site safety
- Ability to negotiate many elbows and be operated remotely
- Water needed only to fill the pipe between the entry point and the blockage, minimizing the amount of liquid added
- Ability to determine the approximate location of the blockage by the amount of water required to back-fill the pipeline.

The primary limitation of the technology is that it can take a relatively long time (days rather than hours) to remove a blockage. It is expected that the approach's safety and cost benefits will outweigh this limitation. The scope for follow-on work is currently being finalized, and it is anticipated that the system will be demonstrated on an abandoned pipeline at the Hanford Site in FY09.

Power Fluidics system testing in the field.

DOE Works to Broadly Communicate D&D Knowledge and Tools

OET's Office of Deactivation and Decommissioning and Facility Engineering (D&D/FE), working in collaboration with the Environmental Restoration work group of the Energy Facility Contractors Organization (EFCOG), established the D&D Hotline at the Hanford ALARA Center to assist the DOE cleanup community by providing a real-time resource for information on potential solutions to cleanup questions. ALARA stands for *As Low As Reasonably Achievable*, which is the mantra of the DOE D&D community and conveys their approach to radiological hazards.The intent of the phone-based Hotline is to rapidly disseminate lessons learned and information on best practices, thus providing solutions to D&D challenges across the DOE Complex and beyond. The Hotline also acts as a central resource for their use of D&D equipment. Hotline contacts can be found on the Hanford ALARA webpage at www.hanford.gov/rl/?page=974&parent=973.

ALARA centers have been established at many of the DOE sites, including Hanford, Savannah River, and Los Alamos National Laboratory. The Hanford ALARA Center has routinely been helping other DOE sites, nuclear power plants, Department of Defense sites, and other sites worldwide.

The Office of D&D/FE is also working with FIU-DOE fellows to develop the D&D Knowledge Management Information Tool (D&D KM-IT), to enhance communications and the exchange of information and ideas collected at the Hanford ALARA Center. The web-based system is currently under development and undergoing phase-one beta testing. More than 100 problems are now available for viewing by the D&D community at dndkm.arc.fiu.edu.

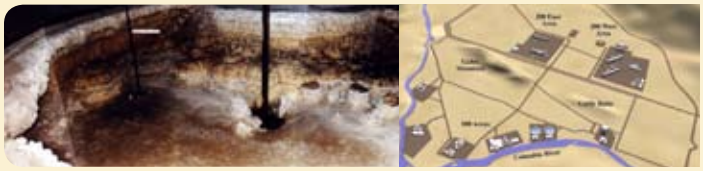
The ALARA centers provide assistance regarding new tools and work practices that can reduce exposure for workers and reduce the risk of spread of contamination, while getting the work done more efficiently.

Aluminum in High Level Waste Presents a Challenge to DOE

During the Cold War, DOE produced HLW as a result of their production of nuclear weapons. Currently the HLW is stored in underground tanks, at the SRS in South Carolina, the Hanford Site in Washington State, and the Idaho National Laboratory in Idaho. DOE is currently working to treat this HLW, so that it can be disposed safely in an off-site repository.

At both the SRS and Hanford Site, plans call for vitrification of the HLW to produce a safe glass form for long-term disposal. The HLW in the tanks is present as liquid, saltcake, and sludge. To vitrify the HLW, the aluminum content must be controlled, because some aluminum (3-5%) improves glass durability, while too much (~10%) can cause undesirable characteristics in the glass as well as processing problems.

Because this aluminum represents a large volume of waste in the tanks, its removal from the HLW could reduce the number of glass canisters that have to be shipped to and disposed in an offsite repository, and the schedule for HLW treatment could be significantly shortened. Studies are also underway to maximize the loading of waste in the glass to minimize the number of LAW canisters.



Saltcake is shown inside single-shell tank 105-B located at the Hanford Site in eastern Washington State.

At SRS, there are ~1440 metric tons (MT) of aluminum in the HLW tanks and 240 MT in H-Canyon, whereas at Hanford, there are ~8660 MT of aluminum in tank waste. Due to site differences in nuclear processing operations, waste at Hanford and SRS requires different processes to dissolve the aluminum in the sludge.

- At SRS, the majority of the aluminum is in a small number of tanks, and waste is staged in batches to feed the Defense Waste Processing Facility (DWPF). As such, aluminum can be dissolved in the tanks.
- At Hanford, aluminum is more widely distributed among the tanks. Plans call for removal of aluminum using caustic additions in the pretreatment portion of the Waste Treatment Plant. However, there is concern about the volumes of the caustic additions. Thus, significant efforts underway include:
  - Evaluation of alternative aluminum removal technologies, such as caustic recycling, using an independent review and engineering-scale testing
  - Testing of improved glass formulations to accept higher levels of aluminum and sodium in the glass
  - An External Technical Review of the LAW Systems Planning at Hanford
  - Further testing to be conducted at the recently constructed Pretreatment Engineering Platform.

Aluminum Treatment Approach Addresses SRS HLW Challenge

An innovative treatment approach will enable SRS to meet their commitment to treat HLW sludge by 2028.

The mass of sludge in the bottom of the SRS HLW tanks is currently estimated to fill ~7900 canisters, which is more than previously projected. Without implementation of any process improvements, SRS would likely be unable to meet their commitment to treat all HLW by 2028.

OET funded SRNL, who worked closely with Washington Savannah River Company, to conduct laboratory-scale studies to demonstrate that significant quantities of aluminum could be removed from the HLW and treated as low-level waste (LLW), thus significantly reducing the volume of waste to be treated by the DWPF. With this reduction in waste feed volume to the DWPF, SRS will be able to meet their commitment to meet the proposed schedule.

The innovative approach involves addition of caustic material (sodium hydroxide) directly into the tanks. The liquid containing the dissolved aluminum is sent to the Salt Waste Processing Facility (SWPF), which treats LLW by incorporating it into a solid grout that will be disposed in above-ground vaults at SRS. After testing in the laboratory, the new approach was demonstrated full-scale in Tank 51 at SRS, where 65% of the aluminum in the sludge was removed after 80 days. This demonstration resulted in a total life-cycle cost savings of $40 million and reduction in the HLW canister count by 100.

If the process were to be used in other tanks that contain aluminum-rich sludge in the SRS tank farms, the volume of sludge requiring HLW treatment will be reduced by 900 canisters, resulting in even greater life-cycle cost savings. The new approach is easy to implement and can be performed in the tank farm rather than in a new facility.

Waste Vitrification Workshop

DOE sponsored a complex-wide waste vitrification workshop, highlighting issues related to improvements to aluminum management in high level waste, on September 24-25, 2008. The workshop convened the Community of Practice of vitrification subject matter experts, including representatives from national laboratories and site operations contractors who provided presentations on:

- Improvements to the process for loading waste into
- Defense Waste Processing Facility (DWPF) and Waste Treatment Plan (WTP) site operations perspectives and process improvements;
- Pretreatment Activities for aluminum dissolution;
- High Aluminum Impacts on Vitrification Processes; and
- Effects Related to DWPF and WTP Processing and Melt Rates.

Proceedings of the workshop will be posted on the Office of Waste Processing (EM-21) web page at www.em.doe.gov.

New Tools to Reduce Technical Risks for EM Cleanup Projects

OET has developed a set of tools to help assure the success of environmental projects by managing technical issues that could prevent a project's success – the "technical risks." These issues may include:

- no technology or engineering solution currently exists to accomplish a project task
- a technology may exist, but is not yet mature enough to be used without additional development
- a technical project risk requires additional focus and/or external review to mitigate risk
- a new technology may not yet be accepted by regulators.

To assist in the management of these types of technical risks, and thus increase the likelihood of successful implementation, OET has developed the following processes: Technology Readiness Assessments (TRAs), External Technical Reviews (ETRs), and Technical Risk Rating (TRR).

TRAs provide a snapshot in time of the maturity of technologies and their readiness for inclusion in the project. OET developed the TRA process based upon Department of Defense guidance. The results of a TRA assist EM in developing plans to mature the technologies and to make decisions related to technology insertion.

Two examples of TRAs are described briefly below.

- The TRA of the Hanford K Basins Sludge Treatment Project identified technologies that were not at the desired readiness level. As the project team reviewed plans to mature the technologies, they decided to step back on the project execution timeline and evaluate different alternatives to meet technology gaps.
- The TRA of the 233Uranium Downblending and Disposition Project at Oak Ridge National Laboratory identified four critical technology elements whose current level of maturity must be further advanced prior to the start of final design efforts.

Following pilot programs at the Hanford and Savannah River Sites, EM issued a guide for performing TRAs in March 2008. Now, other DOE and NNSA organizations are evaluating the EM TRA process for their own use.

ETRs use subject-matter experts from EM, the National Labs, academia, and industry – people who are independent of the project, but knowledgeable in the subject area – to review the progress of major cleanup projects and provide pertinent information for EM to assess technical risk. The results of ETRs are used to develop strategies for reducing identified technical risks and provide technical information needed to support critical project decisions.

The results of a TRA assist EM in developing plans to mature the technologies and to make decisions related to technology insertion.

Technical Risk Rating	Management Impact
	Project technical risk(s) require heightened attention and may require Acquisition Executive decisions on direction or resources.
	Project technical risk(s) require additional focus and may require Acquisition Executive decisions on direction or resources.
	Project technical risk(s) have concerns in several areas and may require additional focus by the Integrated Project Team.
	Project technical risk(s) are manageable. Minor concern in selected areas, but additional focus not required.
	Project technical risk(s) are manageable as planned.

ETRs have been completed to

- assess if operations at some sites have the same problems incurred at others (as was done in the Review of Landfills);
- provide recommendations for technical issues (such as the mitigation and remediation of mercury contamination at the Y-12 Plant); and
- evaluate the basis for a selected technical approach prior to a key decision (as in the Review of the ARROW-Pak TRU Waste Container).

TRRs use project risk assessments, combined with input from TRAs, ETRs and other sources, as a tool for communication between Federal Project Directors and EM management on pressing technical risks. This keeps the team and leadership informed and engaged so that the risk impacts are fully understood and can be effectively managed. The TRR process was developed by OET and SRNL. The TRRs are derived from four criteria – Technology Maturity, Risk Urgency, Handling Difficulty, and Resolution Path – using a stoplight-themed graphic to initiate and prompt discussion of technical risk. The stoplight provides visual representation of the level of concern. Red indicates an area that warrants heightened attention. Green indicates that the technical risks are manageable as planned.

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