

## **COLLABORATION RESULTS - APPLYING TECHNICAL SOLUTIONS TO ENVIRONMENTAL REMEDIATION PROBLEMS**

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### **ABSTRACT**

Within the Department of Energy's Office of Environmental Management (EM), the Office of Science and Technology (OST) identifies and develops innovative technologies that accelerate cleanup of high-priority environmental contamination problems and enable EM closure sites to meet closure schedules. OST manages an integrated research and development program that is essential to completing timely and cost-effective cleanup and stewardship of DOE sites. While innovative technologies can make significant contributions to the cleanup process, in some cases, EM has encountered unexpected barriers to their implementation. Technical obstacles are expected, but administrative challenges—such as regulatory, organizational, and stakeholder issues—must also be addressed. OST has found that collaborative needs identification and problem solving are essential components in overcoming these barriers. Collaboration helps EM meet its cleanup goals, close sites, and reduce the overall cost of cleanup at DOE sites nationwide.

This paper presents examples of OST's collaboration efforts that expedite site closure and solve specific cleanup problems at EM sites.

### **INTRODUCTION**

Under the Department of Energy's Office of Environmental Management (EM), the Office of Science and Technology (OST) is responsible for conducting basic and applied research and technology development, demonstration, and deployment assistance. These efforts are essential to completing timely and cost-effective cleanup, site closure, and long-term stewardship of contaminated DOE sites. OST provides environmental management technologies needed to achieve an end state for each site that safely returns as much land as possible to the public domain and unrestricted usage. OST also tackles complex technical issues for which there are only limited data and partial scientific understanding.

Past operations at DOE sites have contaminated soils, groundwater, and facilities; there are also significant quantities of waste in storage. Contaminants include metals, organic compounds, and radionuclides, often in complex mixtures. Wastes in storage include spent nuclear fuel, high-level and low-level radioactive waste, other nuclear materials, and mixtures of hazardous and radioactive wastes. Due to the complex environmental systems at DOE sites and the nature of the waste, contamination is frequently difficult to locate, characterize, and remediate. Some baseline technologies were once the best available but are often expensive, inefficient, and may pose risks to human health or the environment. Innovative technologies can provide safer, more efficient methods for solving cleanup and closure problems. OST solutions improve worker safety, minimize risk, accelerate cleanup schedules, and reduce expenses. However, for these technology solutions to be effectively deployed, collaboration with site managers, regulators, and stakeholders is necessary. By collaborating with site managers, stakeholders, and regulators, OST is helping to provide targeted solutions that address specific problems.

OST recognized the barriers to technology deployment and began building partnerships with the Environmental Protection Agency, Department of Defense and other stakeholders. Barriers to technology deployment included regulatory approval, stakeholder concern, and site acceptance. Problem owners at sites wanted more reliable cost and performance information. Regulators needed to better understand the impacts of innovative technologies on existing agreements. OST technical and collaborative programs have been developed to specifically address these barriers. OST has a close working relationship with EM's Office of Site Closure (OSC) and is teaming with regulators and stakeholders to solve administrative and technical challenges to innovative technology deployment and site cleanup and closure. This paper describes the outcomes of these collaborative working relationships.

## **WORKING WITH SITES TO ACHIEVE CLOSURE GOALS**

In collaboration with the Office of Site Closure (OSC), OST is focusing on the needs of sites with the nearest-term closure timelines. In particular, OST has committed that there will be no delay in meeting the goal to close the Fernald Environmental Management Project and the Rocky Flats Environmental Technology Site due to technology issues or technical support. To support this objective, OST is establishing a team committed to assisting these sites and will have a dedicated budget so that necessary resources are readily available. A streamlined proposal process will also be developed to provide real-time response to site needs while ensuring high-quality work.

In addition to Fernald and Rocky Flats, OST is addressing a range of problems facing other sites slated for closure in the near term: legacy waste storage, treatment, and disposal; managing nuclear materials processing facilities; shutdown of nuclear reactors; and remediating large tracts of land with soil or groundwater contamination.

Over the past several years, OSC and OST have developed a closer working relationship. When OST implemented its "focus area" approach, the problem holders were incorporated into the OST decision-making process. These focus area teams addressed DOE's major environmental problem areas: deactivation and decommissioning, nuclear materials, subsurface contaminants, radioactive tank waste, and transuranic and mixed waste. Incorporating the problem holders into OST's decision process helped drive decisions about which technologies would be funded for additional development or demonstration to meet site closure needs. In November 1999, OSC and OST further formalized a close working relationship by including a member of OST's staff by matrix into each of OSC's program offices. The organizations were challenged to find creative ways to work together to promote the use of new technologies at closure sites.

The close collaboration between OSC and OST has resulted in cost savings and schedule improvements. In some cases, cleanup that was previously not possible with available technologies can now be accomplished. Teamwork has accelerated cleanup actions and saved money. For example, a large-scale demonstration and deployment project (LSDDP) at Mound provided WaterWorks Crystals and the NoChar Absorbent Polymer. These two technologies solidified liquid wastes and minimized the volume of waste requiring disposal. The two technologies were also applied at other sites, helping OSC make progress towards closure at Ashtabula, Pantex, and the Laboratory for Energy-Related Health Research. Mound was also able to apply the NoChar technology to a new waste stream to solidify ground/crushed vials and residual liquid. NoChar is so effective for this waste type that it replaced the baseline technology.

At the Kansas City Plant, groundwater contaminated with volatile organic compounds was treated using phytoremediation. A reactive barrier was installed in 1998 to intercept and treat the contaminated groundwater, but sampling indicated that some water circumvented the barrier and that some contamination remained even after treatment. Serving as technical consultants, OST personnel determined

that poplar trees would absorb and break down the contamination and achieve hydraulic control of the plume. Deployed in June 2001, this solution is producing cost savings estimated to be upwards of \$500,000. At Pantex, a "low-technology" composting concept using manure and wood chips was implemented to compost soil and debris contaminated with high-explosives and low levels of organic contaminants. This process eliminated the need to exhume and actively treat the soil, saving money and reducing exposure hazards.

### **Closing Fernald by 2006**

DOE is pushing for a 2006 closing for the Fernald Environmental Management Project, 18 miles northwest of Cincinnati. Fluor Fernald, the management and integration contractor for the site, signed a contract that provides a target closure date of December 31, 2010 but will earn a maximum incentive fee for completing the site cleanup by December 31, 2006. Active community groups are also committed to the goal of an early closure.

OST's job on the closure team is to provide technical solutions to help the site meet its 2006 closure goal. For example, Fernald's groundwater is contaminated with uranium as a result of the site's production of uranium metal products for the nation's defense programs. The baseline technology to address this contamination, pump and treat, was estimated to require 27 years and cost over \$80 million. Groundwater Reinjection through Recirculating Wells demonstrated that an optimized extraction strategy could reduce the treatment time to 10 years and reduce costs by more than \$14 million. Groundwater Reinjection is now fully deployed at Fernald. In addition to helping Fernald achieve its closure goals, this technology helps Fernald and EM in general replace a baseline technology with a more effective and less expensive method.

Other examples of OST's immediate contributions at Fernald that will help enable the site to meet its closure goals include the following:

- OST's Integrated Technology Suite (ITS) for Delineating Radioactive Contaminants in Soils project has enabled more than 50% of Fernald's soil to be characterized, generating over \$15 million in cost savings. Fernald project managers needed to accurately characterize the radiological constituents of soil, quickly identify areas needing remediation, and present the information so that site contractors would know where to excavate soil. ITS uses three pieces of real-time radiation equipment: the Mobile Radiation Tracking System, the Radiation Scanning System, and High-Purity Germanium Detectors. Combined with software for gathering, transmitting, and interpreting data, the equipment provides instantaneous data analysis, display, and mapping of the results, accelerating the excavation decision-making process and minimizing excavator down time.
- The Vacuum Transfer System has replaced the baseline packing system for nuclear materials at Fernald and is expected to speed up site closure by 18 months, while improving the safety of site workers. Fernald's inventory of nuclear materials includes nearly 200 metric tons of uranium compounds and more than 220 metric tons of enriched metallic uranium requiring inspection, sorting, size-reduction, stabilization, and repackaging for shipment off site. The Vacuum Transfer System, an automatic repackaging system which successfully started hot operations in June 2001, replaces Fernald's manual repackaging methods. It will be used to repackage approximately 96 metric tons of uranium trioxide, two metric tons of uranium hexafluoride, and possibly 71 metric tons of uranium oxide, depending on disposition paths chosen. Site workers will be protected from radiation exposure because the vacuum transfer is performed within a closed system.
- OST is supporting Fernald's use of Gubka, a Russian technology available through the EM/OST International Program. Gubka reduces worker radiation exposure. Gubka (Porous Crystalline Matrix),

or “sponge” in Russian, is a type of fly ash that is mixed with the waste to form solid blocks and stabilize liquid nuclear materials. Tests by Idaho and Russian scientists are currently underway to determine Gubka’s capability to stabilize solutions of plutonium, americium, curium, and high-level wastes. Many other EM sites have similar waste materials that need stabilization.

- The Remote Prismless Total Survey Station (RPTS) is helping Fernald achieve safer work practices, reduce worker exposure to hazardous environments, and significantly reduce personnel costs. The RPTS for robotic land surveys supports engineering, construction, and environmental remediation activities. This sophisticated system is the latest advancement in “total station” technology. Prismless measurements enable a single instrument operator to make highly accurate survey measurements of remote, inaccessible, or hazardous locations. Robotic operation of the RPTS automatically tracks the surveyor’s position, reducing the survey crew size from three to one. Robotic operation also eliminates the need for personnel to enter potentially hazardous work areas.
- The Universal Demolition Processor (UDP) is helping Fernald demolish numerous steel tanks and an estimated 239,000 cubic yards of concrete slabs, foundations, footers, I-beams, and other structures. The UDP is actually three technologies in one; its exchanging jaw sets enable it to be used as a concrete pulverizer, concrete cracker, or shear capable of cutting thick steel. The UDP’s pulverizer attachment has enabled the site to convert several concrete pads into aggregate for reuse in temporary support roads around Fernald’s On-Site Disposal Facility.

OST delivers more than innovative technologies; it also works with the sites to provide technical assistance, tapping into a wide network of DOE experts on a range of environmental issues. In 2001, OST collaborated with Fernald by sending experts on tanks-related issues to strategize with users on waste retrieval from Silos 1 and 2 (known as the K-65 Silos). The silos contain more than 240,000 cubic feet of low-level waste from the days when Fernald processed high-grade uranium ores. With technical assistance from OST, Fernald implemented the Accelerated Waste Retrieval Project to remove the waste from Silos 1 and 2 and place it in transfer tanks.

To ensure Fernald’s seamless transition from environmental cleanup to long-term stewardship, OST is teaming with Fernald project management and stakeholders in developing a comprehensive post-closure care, inspection, and monitoring plan. The Fernald Post-Closure Stewardship Technology Project is currently identifying, demonstrating, and deploying technologies to ensure that the Fernald On-Site Disposal Facility (OSDF) is adequately maintained and monitored for perpetuity. During FY 2001, an independent, broad-based, and objective stewardship team identified several crucial needs related to monitoring the OSDF final cover and evaluated candidate monitoring technologies. The team will also investigate needs and technologies for collecting, monitoring, and passively treating leachates from the OSDF. Another focus will be to provide a repository for long-term retention and retrieval of data and images.

### **Rocky Flats Is Closing Down**

The mission of the Rocky Flats Environmental Technology Site is to accomplish closure by the end of 2006. For this DOE site, about 16 miles northwest of Denver, a safe cleanup and shutdown is now the primary mission after nearly 40 years of nuclear weapons production. OST is playing an important role in the Rocky Flats closure by working with the site to supply cleanup technologies. Some of these technologies are helping the site plan for and execute safer, more effective, and more efficient methods for size-reducing and decontaminating large equipment, characterizing equipment and facilities, certifying wastes and structures, and improving worker safety and efficiencies. Improved technologies have had a big impact on worker safety at Rocky Flats. One way to protect workers is to ensure they are not exposed unnecessarily to radioactive materials or radiation. Another way is to automate processes to remove

workers from potentially hazardous situations. Recent projects have introduced a variety of technologies to help Rocky Flats achieve its closure goals:

- To protect workers from airborne radioactive contamination during size-reduction, Inner Tent Chambers (ITC) are being used at the site. Rocky Flats has more than 900 plutonium-contaminated gloveboxes, which must be removed, size-reduced, and disposed of as radioactively contaminated waste. ITCs are hard-walled containment structures that not only separate workers from direct contact with large contaminated materials that need to be cut into small pieces, but also support multiple cutting options. In September 1999, the first-generation ITC was installed in Building 771 to protect workers during the manual size-reduction of gloveboxes. The most recent design enables workers to use hydraulically and mechanically actuated robotic arms for plasma arc cutting and loading cut pieces into boxes.
- Rocky Flats' adoption of the Standard Waste Box (SWB) as the primary waste container for packaging large pieces of equipment is lowering its D&D costs: less size-reduction is needed, and fewer containers require certification. The SWB is a significant improvement over the 55-gallon drums that were previously used. To certify its SWBs, Rocky Flats is using the Standard Waste Box Counter, a mobile technology for quantifying the concentration of transuranic waste in the SWBs without the necessity of opening the containers and certifying the waste inside.
- Instead of reducing the size of all equipment contaminated with transuranics and shipping it to WIPP, OST will investigate how decontamination technologies can be used to lower the costs of disposal. Five technologies are being compared to explore decontamination of gloveboxes, tanks, and equipment as the alternative to size-reduction. The technologies are carbon dioxide pellet blasting, sponge abrasive blasting, acid etching, mild acid precipitation, and mild acid etching using tetravalent cesium dissolved in nitric acid. To be feasible, decontamination will have to lower contamination levels enough to enable reclassification from transuranic to surface-contaminated objects, thereby permitting shipment to low-level disposal sites.

### **Closing Landfills at the Nevada Test Site**

The Nevada Test Site (NTS) has seen more than four decades of nuclear weapons testing. Between 1951 and 1992, DOE conducted more than 900 nuclear tests/detonations on this remote 1,375-square-mile property in southern Nevada, 65 miles northwest of Las Vegas. Since 1992, when a moratorium was called on nuclear weapons testing, the NTS mission has diversified into hazardous chemical spill testing, emergency response training, conventional weapons testing, and waste management and environmental technology studies. NTS's environmental management mission is scheduled for completion in 2014; however, the site is scheduled to remain open to receive low-level waste from other sites until 2070.

Three areas at NTS are preparing for closure, including approximately 90 acres of low-level waste landfills and landfills with covers that comply with the Resource Conservation and Recovery Act (RCRA). Innovative technologies supplied through collaboration with OST are helping NTS find safer, more effective, and less expensive ways to accomplish this mission. Examples include the following:

- OST-sponsored research on alternative landfill covers is yielding valuable information on better, less expensive ways to cap hazardous waste landfills, particularly those in arid areas. The Alternative Landfill Cover Demonstration is in its fourth year of collecting data for evaluating the performances of variously constructed covers. This side-by-side comparative testing has shown the superiority of a simple cover composed of a thick layer of native soil planted with a variety of shallow-rooted grasses indigenous to the region. This single-layer design is an evapotranspiration cover, which captures the

moisture from precipitation and, through the processes of evaporation and plant transpiration, sends the moisture back into the environment before it can travel down through the landfill. It's easier and less expensive to construct and more effective than the multiple layers of the baseline RCRA cover, especially in arid regions.

- The evapotranspiration cover installed in Area 3 was easy to construct, will require little maintenance, and saved the site approximately \$450,000 on the 2-acre landfill. In the event of landfill settling, the cover will be self-sealing; the only maintenance required will be adding more soil to direct rainfall off the cover. Even more benefits are expected to accrue as DOE continues to collect performance data for evaluating the long-term reliability of various landfill cover designs. In addition to helping NTS achieve closure goals for its landfills, this technology helps NTS and EM in general replace a baseline technology with a more effective method.

### Wrapping Up Cleanup at Los Alamos

Los Alamos National Laboratory (LANL) has a research mission that will outlive its environmental remediation and waste management projects. Plans call for the laboratory to complete its environmental restoration project by 2008 and to have decontaminated and decommissioned two on-site transuranic waste reduction and repackaging facilities by FY 2017. The site will maintain most of its 43-square-mile property but is considering transfer of up to 7,000 acres to the county for industrial use. Land and facilities that DOE retains will be remediated to enable industrial use; land that is released will be remediated to enable unrestricted use.

Los Alamos has worked with OST to deploy several technologies that will assist in site closure:

- Two deployments of the Combined Thermal/Epithermal Neutron Interrogation (CTEN) at the Radioassay and Nondestructive Testing Facility have saved LANL \$80,000. To meet increasingly stringent shipping and disposal regulations, LANL needed an improved method of ascertaining the transuranic and low-level waste concentrations of containers without having to open the containers, and CTEN has provided this capability. CTEN interrogates the waste drum with both thermal and epithermal neutrons, yielding a more accurate measurement of transuranic radionuclides than the baseline technology.
- Heap Leaching of Uranium from Soils reduced an estimated 25,000 cubic yards of contaminated soil and avoided the expense of excavating soil whose transuranic levels were greater than 100 nanocuries per gram. The technology is an innovative approach to cleaning LANL's firing range sites and was deployed in May 2001 at the E-F Firing Site, where uranium shells had previously been disposed of by destruction with high explosives. In the Heap Leaching process, a sodium bicarbonate solution is used to leach the uranium from the soil, and the uranium is then recovered from the solution filters.
- To reduce risk to workers during excavation, the Remote Excavator is being used at LANL. The Remote Excavator enables a worker to operate a full-sized excavator using a series of remote controls and computer view screens. The worker is safely housed in a building during the operation. This alternative to working directly in the field reduces worker exposure to radiation and heavy equipment hazards.

OST is also working with LANL through its large-scale demonstration and deployment projects (LSDDPs), which demonstrate how certain technologies developed through the private sector can be used to solve D&D problems. The site has hosted two LSDDPs—one completed and another ongoing. The

completed TRU Waste Characterization, Decontamination, and Disposition LSDDP at LANL brought four successful technologies to the attention of the DOE complex:

- AeroGo Air Lift Pallet System floats loads on a virtually frictionless film of air.
- Vehicle and Cargo Inspection System is a highly penetrating gamma ray imaging system that noninvasively images crate contents.
- Mobile Characterization System for Large Crates is a mobile nondestructive examination system.
- Mega-Tech Hydraulic Shear cuts materials faster than the baseline technology. It cut eight legs from plutonium gloveboxes in 15 minutes, while the reciprocating saw took 45–60 minutes, including a rest break to alleviate worker fatigue.

The Los Alamos Tritium Technology Deployment LSDDP will deploy proven, cost-effective innovative technologies for removing an estimated tritium inventory of 125–140 grams. The tritium must be removed before LANL's Tritium Systems Test Assembly Facility can be transferred for deactivation and decommissioning.

### **PARTNERING WITH EM SITES TO DEPLOY INNOVATIVE TECHNOLOGIES**

A major barrier to deployment of innovative technologies is the risk of trying an alternative technology for which there may not be significant performance data. To address this barrier, OST created the Accelerated Site Technology Deployment (ASTD) program to bridge the gap between development and deployment of new technologies for environmental cleanup across the DOE weapons complex. One of the key features of ASTD is that site cleanup managers share the risk of trying new technologies with OST by leveraging dollars from both organizations. Proposals for new projects are submitted by cleanup managers at EM sites, ensuring integration of an innovative technology with the site's cleanup program. Another ASTD requirement is the collaboration with other sites where the same technologies could be applied in a subsequent project. As a result, ASTD has been successful in encouraging sites to work together to utilize new technologies for similar problems at multiple DOE sites. Seventy-six ASTD projects were initiated between FY 1998 and FY 2001 at 22 DOE sites, managed by ten field offices. More than one hundred thirty deployments of new technologies occurred during the first three years of the program. Table 1 below provides some examples of ASTD-project impacts to the EM cleanup program.

Table I. ASTD impacts on EM's cleanup program

Field Office	Cleanup Accomplishment	Associated Project
Albuquerque	7.4M gallons water treated (uranium [U] + trichloroethylene [TCE])	Monticello and Kansas City Permeable Walls
	3,000 cubic yards soil treated (explosives)	Pantex Composting of High Explosives
Chicago	350M gallons water treated (TCE)	Brookhaven In-Well Air Stripping
Idaho	30,000 square feet metal cut and buildings removed, and 3.8M pounds waste contained	Integrated D&D
	3,700 cubic yards concrete recycled	Release of Concrete for Recycle
Nevada	3,735 square meters floor surface surveyed	Position-Sensitive Radiation Monitoring System
Oak Ridge	825 pounds TCE removed from groundwater	Dynamic Underground Stripping at Portsmouth
	300,000 gallons waste retrieved	Enhanced Sludge Retrieval System
	7,700 Curies removed	Out-of-Tank Modular Evaporator and Cesium Removal System
	268,000 gallons water treated	
	10,668 cubic feet debris encapsulated	Macroencapsulation
Ohio	4,882 cubic yards soil processed	Segmented Gate System (7 deployments)
	12,000 cubic feet (560 tons) of reactor shield cut	Diamond Wire Saw
	2,300 cubic yards material processed	Universal Demolition Processor
	50,000 Curies treated	TRU Waste Oil Solidification (NoChar)
	740 acres soil surveyed	Integrated Technology Suite
	280 cu ft HLW reduced to 20 cu ft HLW & 60 cu ft LLW	Processing of Vitrification Expended Materials at West Valley
	9 buildings removed	Integrated D&D
Richland	188,000 gallons waste monitored	Slurry Monitoring
Rocky Flats	4.0M gallons water treated (U + TCE)	Permeable Reactive Barrier
	94,000 square meters surface surveyed	Position-Sensitive Radiation Monitoring System
Savannah River	7,500 linear feet pipe inspected	Integrated D&D (Pipe Explorer)
	70,000 pounds TCE removed from groundwater	Dynamic Underground Stripping
	>2.5M gallons water treated	Nuclide Removal System

## OTHER WAYS OST USES COLLABORATION

OST works with other DOE offices, national laboratories, private industry, academia, other federal agencies, international organizations, and others in the science and technology community. This extensive network of partners enables OST to leverage resources, mobilize participation, and minimize duplication of effort. The result is accelerated use of technically defensible solutions for cleanup and environmental stewardship.



Although some environmental issues are unique to DOE, others are common to multiple federal agencies. By tackling the common problems together, the agencies can achieve a greater impact from their R&D budgets. A prime example of multi-agency cooperation is the Interagency DNAPL Consortium (IDC), comprising representatives from EPA, NASA, DOD, and DOE. The agencies agree that dealing with DNAPLs—dense, nonaqueous-phase liquids—is one of the most difficult environmental challenges they face. DNAPLs typically include industrial chlorinated solvents—trichloroethylene, perchloroethylene, and carbon tetrachloride. DNAPLs are toxic, only marginally soluble in water, denser than water, and subject to becoming trapped in pore spaces between soil particles.

IDC is cooperatively testing and documenting the cost and performance of three innovative technologies for treating DNAPLs—compounds that have traditionally proven difficult to characterize and remediate. Side-by-side technology demonstrations are being conducted at Launch Complex 34 at the Cape Canaveral Air Station in Florida. Comparative cost and performance data collected under the same field conditions expedites regulatory acceptance and the use of these remedial technologies. The third and final demonstration, Dynamic Underground Stripping and Co-Air Injection, began in July 2001.

To assist EM in developing a comprehensive picture of the regulatory environment, OST is also focusing on existing and proposed regulatory requirements for post-closure activities. This initiative is being led by OST's Long-Term Stewardship office and will include working with regulators to identify those site-specific post-closure requirements that are in place and being met as well as impending compliance documents impacting EM's long-term stewardship responsibility.

Through international partnerships, OST is spanning the globe in its search for environmental technologies to clean up DOE sites. OST works with world-class scientists, sharing experiences and jointly developing innovative technologies in areas of mutual interest. A recent project between OST and the Institute for Ecology of Industrial Areas in Katowice, Poland has resulted in a first-ever deployment the Radiological/Petroleum Contaminated Soils Bioreactor at DOE's Savannah River Site (SRS). Developed and deployed in Poland, the bioreactor is a mobile, ex situ technology that can be used for on-site batch remediation of organically contaminated soil. The SRS deployment will be the first test of the bioreactor on small amounts of mixed low-level radioactively contaminated soil currently in storage. Without such technology, disposal would be impossible, and the contaminated soils would have to be stored indefinitely.

Some of the most innovative science and engineering work being done can be found within U.S. universities and businesses. OST is tapping these reservoirs of knowledge and creativity through university and industry partnerships, drawing on the best knowledge and experience throughout the country and providing complementary scientific and engineering skills directly to EM. The benefits of these partnerships are mutual. For example, a researcher at Illinois Institute of Technology leveraged funding from the Environmental Management Science Program to develop a new antifoaming agent that is deployed at the Defense Waste Processing Facility. This material is also expected to have broad application in waste tank remediation throughout the DOE complex. The basic research performed during this project was vital to understanding the complex interaction of the antifoaming agent.

Similarly, OST also provides opportunities to private sector companies, especially small businesses, to penetrate the DOE market with their technology solutions and services. OST supports many companies that conduct applied research, development, demonstration, testing, and evaluation, enabling them to achieve earlier market entry than would be possible under exclusively company-funded development. In turn, as these technologies become available, many are now being deployed at multiple DOE sites. To date, OST has supported the development of more than 250 technologies that are now commercialized.

## **PARTNERSHIPS WITH REGULATORS AND STAKEHOLDERS**

### **Interstate Technology and Regulatory Cooperation Work Group**

Realizing the importance of regulatory acceptance of innovative technologies, OST helps to fund the Interstate Technology and Regulatory Cooperation (ITRC) Work Group, a state-led, national coalition of environmental regulators and other stakeholders from both the public and private sectors working to break down regulatory barriers to the use of new technologies. DOE's investment in ITRC is expanding the appropriate use of innovative technologies and helping reduce the costs of compliance.

But it takes more than funding to solve cleanup problems with innovative technologies. Before ITRC existed, it was difficult to convince environmental contractors and regulators to use new remediation technologies. One roadblock to deployment is knowledge and understanding of the technical and regulatory issues associated with innovative technologies. Through ITRC-developed guidance documents and training courses, regulators and environmental consultants have become more open to using innovative remediation technologies.

OST co-funded projects with the Remediation Technology Development Forum, gaining matched contributions from DOD and the private sector. But it was only after involving ITRC that progress was made in widespread deployment of innovative technologies. ITRC provides free web-based training courses and guidance documents geared toward the regulator community. ITRC-sponsored training on emerging technologies helps participants improve their understanding of scientific, engineering, and regulatory requirements. Through both classroom and Internet delivery, ITRC has trained more than 10,000 people on natural attenuation, permeable reactive barriers, enhanced in situ bioremediation, phytotechnologies, and other topics. Participants have joined in the training from every state in the US and every habitable continent worldwide. These classes help improve regulators' knowledge about innovative technologies and strengthens the basis for their decisions. Regulators say they feel they have a stronger understanding of what to look for and are able to make better decisions about the application of innovative technologies to cleanup problems.

For example, after taking ITRC's training courses on natural attenuation, multiple states reported increased use of natural attenuation as part of site cleanup remedy selection and implementation. Regulators in Kansas accelerated approval for a natural attenuation pilot for chlorinated solvents by 50%. They also proactively suggested places where natural attenuation could be used, and felt they were making more informed decisions about locations where natural attenuation was rejected. Regulators in Colorado said they felt more confident about natural attenuation after taking ITRC's course.

In another example, ITRC technical and regulatory guidance documents have helped regulators achieve a more efficient review of remedial work plans that incorporated permeable reactive barriers (PRBs). Colorado Department of Public Health and Environment (CDPHE) site managers estimate that they saved 10–25% of their total review time by relying on these documents. The ability of CDPHE to approve use of PRBs, assisted by ITRC documents, resulted in significant savings of public funds.

Another roadblock to deployment is site-specific review and regulatory concerns. When a technology is deployed at one site, it is not necessarily a "shoe in" for any other site. ITRC's network of experts from state environmental agencies, industry, federal agencies, and stakeholder groups has helped speed up technology deployment at multiple sites. For example, with ITRC's help, the Segmented Gate System (SGS) was successfully deployed at Pantex and then at Ashtabula, LANL, and Brookhaven. SGS mechanically sorts radioactively contaminated soil from clean soil, reducing the volume of waste to be packaged, transported and disposed.

ITRC has also helped in the area of regulatory reform. Some existing regulations are either unclear or prohibit the use of new technologies. ITRC helped remove barriers to deployment for injection/reinjection technologies such as in situ bioremediation. Working with California and 14 other states, ITRC asked EPA to clarify a Resource Conservation and Recovery Act ruling (RCRA 3020 (b)) based on the need to reinject contaminated groundwater. EPA responded positively, and as a result practitioners and regulators alike can now feel confident that they know and understand the regulatory requirements under RCRA for implementing in situ bioremediation.

For more information on ways ITRC is helping spur technology use at DOE, DOD, and other sites across the country, visit its Web site at [www.itrcweb.org](http://www.itrcweb.org).

### **Finding Alternatives to Incineration**

Public concerns about off-gases and more stringent EPA requirements make it necessary for DOE to find alternatives to incineration. For more than five years, OST has sponsored R&D projects to meet site needs for destruction of mixed waste containing transuranics, mercury, or explosives—classes of mixed waste that are not amenable to incineration. In particular, OST's Transuranic and Mixed Waste Focus Area is evaluating the promising technologies selected by the Secretary of Energy Advisory Board's Blue Ribbon Panel on Emerging Technological Alternatives to Incineration. The Blue Ribbon Panel also suggested increased opportunities for public involvement throughout the technology-development process, so the Alternative Technologies to Incineration Committee (ATIC) was created as a citizens' working group to monitor progress and provide direct input into DOE's technology development efforts. Recognizing that public acceptance is an important aspect to finding alternatives to incineration, OST is actively participating in the committee.

In June 2002, OST and ATIC are co-sponsoring a stakeholder forum in Denver to attempt to incorporate stakeholder views into the evaluation of technologies. The workshop will address the status of research into alternatives to incineration, including steam reforming and thermal desorption, and the potential use of these technologies. Stakeholders will be asked to provide their input on the technology evaluation. For example, if stakeholders say they view air emissions as a high priority, OST can ensure that type of data is gathered and communicated not only to technical evaluators, but also to the public. An "ATI Primer" will be distributed to forum participants and will include basic details on incineration technology and alternative technologies, the challenges and questions faced in selecting certain technologies for managing mixed low-level and transuranic waste, and a history of past experiences with these technologies.

### **CONCLUSION**

Collaboration successes that help achieve closure goals come in all sizes and shapes and affect both large and small sites. Some examples save millions of dollars and years of time; others simply make a cleanup task easier and safer. In some cases, the collaboration effort has less to do with technology than with administrative or regulatory issues. Partnerships with stakeholders and regulators enable OST to address concerns in advance, provide the information needed for decision making and input, and increase knowledge about innovative technologies. OST has found that collaborative needs identification and problem solving are essential components in the process of deploying innovative technologies that support site closure and solve EM's most difficult cleanup challenges. Collaboration helps EM meet its cleanup goals, close sites, and reduce the overall cost of cleanup at DOE sites nationwide.