

US DOE Office of Technology Innovation and Development – Integration of the EM R&D Program in 2010 and Beyond – 11529

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ABSTRACT

The Technology Innovation and Development Program in the DOE Office of Environmental Management (EM) seeks to reduce the technical risks of EM project performance by either developing and maturing new technologies or using existing technologies to overcome technical difficulties that affect the life-cycle schedule and cost of the EM clean-up mission. The Office of Technology Innovation and Development (OTID) focused efforts in fiscal year 2010 (FY 2010) on integrating the expanded applied research and development (R&D) program across three program areas--Tank Waste Processing, Groundwater and Soil Remediation, and Deactivation and Decommissioning--and in FY 2011, introduced a fourth program area, Nuclear Materials Disposition.

The overarching goal of the EM Technology Innovation and Development Program is to bring technologies to bear that can reduce the life-cycle resources required for the clean-up of nuclear waste and aging infrastructure. The program achieves this by reducing technical barriers and uncertainty, addressing emerging technical issues, and leveraging investments in scientific research conducted by other Departmental programs, universities, industrial partners, and international collaborations. The OTID actively manages EM-sponsored R&D through strong leadership and flexibility. In FY 2010, the Office accomplished significant progress in integration of the R&D program through development of an Impact Plan that describes the potential for a 25% reduction in life-cycle costs through EM R&D, a plan for enhanced communications to aid in collaboration, and a comprehensive R&D Plan that outlines goals of R&D efforts. The OTID also instituted Quarterly Program Reviews in FY 2010 to provide timely technical and fiscal status of R&D tasks and completed a Communications Plan to foster increased awareness and advocacy of the program. The Office also issued an International Program Strategic Plan to outline cooperation and collaboration initiatives with the international community that has similar nuclear legacy management experience and expertise.

This paper will provide an overview of the R&D program, present the overall progress of program integration initiatives that led to technical accomplishments in FY 2010, and plans for the future.

INTRODUCTION

The mission of the Department of Energy's (DOE's) Office of Environmental Management (EM) is to clean up the environmental legacy of nuclear weapons research and production during the Cold War. That mission includes cleaning up nuclear waste, contaminated groundwater and soil, nuclear materials, and contaminated facilities covering two million acres of land in thirty-five states. EM's principal program goals include timely completion of tank waste treatment

facilities, reduction of the life-cycle costs and acceleration of the cleanup of the Cold War legacy, and reduction of the EM footprint.

The mission of the EM Technology Innovation and Development program is to transform science and innovation into practical solutions to achieve the EM mission. During fiscal year (FY) 2010 (October 2009-September 2010), EM focused on accelerating environmental cleanup by expeditiously filling identified gaps in available knowledge and technology in the EM program areas.

This paper describes some of the approaches and transformational technologies in tank waste processing, groundwater and soil remediation, nuclear materials disposition, and facility deactivation and decommissioning developed during FY 2010. This paper also describes R&D program integration initiatives during FY 2010 and additional plans for the future that will expedite accomplishment of EM's most pressing program goals.

EM R&D PROGRAM AREA PROGRESS DURING 2010

TANK WASTE PROCESSING

There are currently almost 90 million gallons of radioactive waste safely stored in 230 tanks at DOE's Hanford, Savannah River, and Idaho sites. The chemistry and forms of the wastes vary widely, as do the tanks containing them. Processing this radioactive tank waste has long been recognized as one of the most technologically complicated efforts in the Department. Retrieval, processing, and immobilization involve highly coordinated process steps that often require tailored solutions based on the specific wastes, tank conditions, and situations.

During FY 2010, DOE EM took three major programmatic actions to expedite development of transformational technologies to optimize tank waste processing. The first was restructuring the Tank Waste Processing Program based on recommendations in the March 2009 *Advice on the Department of Energy's Cleanup Technology Roadmap, Gaps and Bridge* [1]. In that report, the National Research Council of the National Academies identifies five technology gaps directly applicable to the tank waste program. The second action was sponsoring the Tank Waste System Integrated Project Team (IPT) to perform a technical evaluation of potential strategies to significantly improve the tank waste system. The IPT's *Technical Evaluation of Strategies for Transforming the Tank Waste System* [2] issued in January 2010 recommends transformational waste processing strategies that are feasible but require technology development to be successful. Those actions culminated in the June 2010 issuance of the *EM Tank Waste Research and Development Plan*, which describes major multi-year initiatives to develop transformational technologies supporting the general tank waste strategy to safely retrieve, stabilize, and dispose of radioactive tank waste and close the waste tanks.

Pursuit of enhanced tank waste processing strategies during FY 2010 has resulted in significant progress in the development of transformational waste processing technologies. The key strategies addressed in FY 2010 were:

- Develop at-/near-tank processing to increase waste processing rates
 - Small column ion exchange

- Rotary microfilter
- Increase waste loading to reduce high level waste (HLW) canister production
 - Advanced silicate glasses
- Develop next-generation melters to improve waste processing
 - International collaboration to develop Advanced Joule-Heated Ceramic and Cold Crucible Induction Melters
- Deploy alternative treatment processes to generate new waste forms and reduce the volume of waste
 - Fluidized bed steam reforming
- Develop advanced separations processes to accelerate waste retrieval and minimize downstream high-level waste disposition
 - Next-generation cesium solvent.

GROUNDWATER AND SOIL REMEDIATION

DOE is tasked with remediating some of the largest groundwater and soil contamination problems in the world, in terms of the volume of affected groundwater and soil, number of plumes, complexity of hydrogeologic settings, and diversity of contaminant types. DOE must remediate 1.8 billion cubic meters of soil, groundwater, and sediment in highly diverse environments that are contaminated with organics, metals, and radionuclides. Current groundwater and soil remediation challenges that will continue to be addressed in the next decade include cost-effective characterization, remediation, and monitoring of contaminants in groundwater and the vadose zone, i.e., the water-unsaturated sediment below the soil and above the groundwater.

The complexity of the remediation effort requires a multi-faceted R&D program; with focuses on multiple initiatives and field sites for applied research. The Applied Field Research Sites interconnect with one another to enable development and implementation of holistic remedial strategies based on a scientific understanding of the subsurface environment. Attenuation based remedies, deep vadose zone, and mercury characterization and remediation initiatives form the core of the three Applied Field Research Sites at the Hanford, Savannah River and Oak Ridge sites. These Applied Field Research Sites will facilitate the demonstration of new technologies and processes at a field scale based on these technical initiatives.

The near-term focus and funding have primarily targeted remediation technology enhancements and development of a high-performance modeling and simulation tool. The OTID Office of Groundwater and Soil Remediation R&D program areas of focus for FY 2010 included:

- Attenuation-Based Remedies for Chlorinated Solvents in Groundwater and the Vadose Zone
- Attenuation-Based Remedies for Metals and Radionuclides in Groundwater
- Advanced Remediation Methods for Metals and Radionuclides in the Vadose Zone
- Mercury Characterization and Remediation
- Advanced Simulation Capability for Environmental Management

DEACTIVATION AND DECOMMISSIONING

EM's current Deactivation and Decommissioning (D&D) life-cycle scope comprises over 3000 facilities, including over 1000 nuclear and radioactive buildings located across the DOE complex and accounting for close to 25 percent of the Department's total buildings and other structures, and nearly 47 percent of the Department's replacement plant value. The portfolio includes multiple nuclear production reactors, over 100 test and research reactors, multiple football-field-size gaseous diffusion plants, chemical processing plants, fuel and weapons component fabrication facilities, canyons and radionuclide separations facilities, laboratories, hundreds of miles of buried pipelines, and a myriad of other contaminated facilities. A large majority of the facilities to be decommissioned in the DOE complex are one-of-a-kind or unique to DOE with unprecedented scope and complexity. In many instances the needed technologies are yet to be developed or will require significant re-engineering to be adapted to meet DOE needs. With the more complex D&D projects scheduled into the out years, the opportunity exists to address needed technical improvements and advancements to achieve cost and schedule expectations.

The D&D R&D program supports the identification, development, and timely deployment of adaptive and transformational technologies that are needed for the safe closure of nuclear, radiological, and industrial facilities. Priority projects pursued in FY 2010 that are expected to produce demonstrable D&D benefits in the near future include:

- Remote Radiological Characterization and Stabilization
 - RadBall™
 - Stack Characterization System
 - Integrated Remote Fixative Spraying Platform
- Decontamination
 - DeconGel™
 - Sodium Passivation
- In situ Decommissioning
 - Materials Behavior and Degradation
 - Sensors and Monitoring
 - Knowledge Management.

NUCLEAR MATERIALS DISPOSITION

The EM Nuclear Materials Disposition (NMD) Program is managing and defining disposition paths for spent nuclear fuel, challenging materials, and plutonium. In collaboration with other government organizations, the NMD R&D program is ramping up to develop approaches and technologies to disposition those nuclear materials, including characterizing, treating/stabilizing, and packaging for disposal and risk-reduction during extended storage.

The NMD R&D program is divided into three areas:

- Spent Nuclear Fuel Management
- Challenging Materials Disposition
- Plutonium Materials Management and Disposition.

R&D PROGRAM INTEGRATION INITIATIVES IN 2010 AND 2011

IMPACT PLAN

An Impact Plan was developed by a consortium of individuals from DOE offices, national laboratories, and industry to examine the benefits of an increased R&D budget on the life-cycle cost of clean-up across the DOE complex. Under an annual funding level of \$150 million per year over the next five years, the plan proposes a potential return on investment (ROI) based on past examples of actual savings realized from technology development and insertion at the Fernald, Mound, and Ashtabula sites. The plan determined that the \$200+ billion EM Program life-cycle cost could be reduced by \$50 billion, through all four areas of the OTID R&D program (waste processing, groundwater and soil, nuclear materials and deactivation and decommissioning.) The Impact Plan includes examples of key program areas that could benefit greatly by increased investment in R&D to develop new tools and approaches that will reduce worker risk and the cost and schedule for cleanup.

In order to achieve those goals, the OTID is pursuing increased emphasis on integration, collaboration, and communication. The OTID also has instituted a rigorous peer review process that, when combined with Quarterly Program Reviews, will assure investment in high ROI areas. Through strong leadership, OTID will reach out to the greater scientific community to ensure that the best and brightest ideas are incorporated into the program.

COMMUNICATIONS PLAN

The Communications Plan is designed to improve communications both within the OTID program and with key stakeholders outside the program. Within the program, the communication strategies outlined in this plan will allow senior EM and OTID management to be cognizant of research programs and successes, and facilitate interactions among OTID staff and principal investigators working in laboratories and institutions. The themes and strategies in this plan will help bring information and technical solutions to the attention of stakeholders involved in executing the clean-up mission. Further, these technology innovations and solutions will be communicated to other stakeholders including regulators, legislators and the public to support the formulation of informed decisions regarding the clean-up mission.

The plan was developed by assessing key initiatives and communications needs within the OTID. The major conclusions from this assessment were that OTID needs to “do a better job of getting the word out” regarding ongoing initiatives and significant accomplishments. The assessment also concluded that improved clarity and consistency of the message was also needed, and that the Office needed to be timelier and “hard hitting” in conveying the message. Additionally, attention was needed in communications and information sharing among personnel involved in the program to improve efficiency. Based on this assessment, four themes were

identified: i) developing a stakeholder engagement strategy, ii) improving communications outreach; iii) improving consistency of the OTID message; and iv) improving communications within the OTID program to facilitate information exchange and efficiency.

In FY 2010, the OTID launched two initiatives designed to address the themes outlined in the Communications Plan. Within the existing program, the Office commissioned work to develop a “collaboration portal”. Initially the electronic web-based portal will allow efficiency and consistency of communications between OTID management and staff, field management and performers of OTID scope. The second initiative, the OTID “roadshow”, was launched to communicate OTID technology plans and progress to a broader more diverse audience. The roadshow will take the form of face-to-face meetings with field sites and technology developers, as well as, communications at forums and technical exchange venues.

The Communications Plan will be regularly monitored by the complex-wide Communications Team and by OTID management. Feedback will be solicited to gauge the effectiveness of the communication actions and the plan will be revised as needed.

INTERNATIONAL PROGRAM STRATEGIC PLAN

The OTID released the *International Program Strategic Plan 2010-2015* [3] in FY2010. The EM International Program develops formal relationships with international organizations and organizations within individual nations that enable exchange of scientific and technical information. These collaborative activities foster communication and lessons in the global discovery of emergent technologies. In FY 2010, EM launched efforts through a strategic plan to expand its role with multilateral international organizations in order to tap into best science being used in the field. The EM International Program strategically expanded existing international agreements and established new agreements that assist in developing effective international waste management strategies and formalize undertakings with international partner countries. The OTID expanded existing initiatives in Waste Processing and mounted several new agreements on initiatives in Groundwater and Soil Remediation and Deactivation and Decommissioning, marking the broadest international scope expansion for OTID support in several years.

RESEARCH AND DEVELOPMENT PLAN

The OTID developed an EM Research and Development Plan (R&D Plan) that describes details of the technology development initiatives that will result in reductions in the EM life-cycle cost and schedule outlined in the Impact Plan. The R&D Plan was developed based on meetings and visits to field sites to understand their milestones, various technical workshops with diverse attendees from within the EM complex, industry and academia, and through meetings with the DOE Office of Science and other DOE offices. The deployment of the technologies developed through execution of this plan support the *Roadmap for EM’s Journey to Excellence* Goal 2: Reduce the life-cycle costs and accelerate the cleanup of the Cold War environmental legacy [4]. The R&D Plan outlines the EM R&D program strategic initiatives that EM will invest in to achieve these transformational impacts.

The portfolio outlined in the R&D Plan has been developed to provide technical solutions that can be deployed in a timely manner to provide greatest impact within authorized funding levels. It is clear from the development of the R&D Plan that EM lacks the resources to execute all but the most critical elements. In order to maintain a lasting effect on the overall life-cycle of over \$200 billion and meet a goal of reducing that cost by 25%, a greater investment in R&D is required (as outlined in the Impact Plan). The R&D Plan describes the specific milestones and deliverables that support the high level goals within the R&D program to achieve the Impact Plan ROI. Progress toward achieving the goal of 25% savings will be reviewed annually within the R&D Plan framework to determine the need to modify the overall portfolio relative to this goal.

The history of this program has demonstrated the positive impact technology and innovation can have on the reduction of cost and schedule. Improvements in nuclear safety and environmental performance and remediation without compromising the health and safety of the public are achievable goals. In summary, the R&D Plan implements a strategy of technology research and development through leveraging, leadership, and integration to reduce EM cleanup life-cycle costs.

PROGRAM REVIEWS

The OTID managed R&D program funding level increased from FY 2009 to FY 2010 necessitating increased management focus and driving the need for timely decisions based on technical results and fiscal status. To aid in the assessment of R&D initiatives; peer reviews have been incorporated into the program to ensure the use of the best science available.

The OTID also instituted Quarterly Program Reviews across all areas of the program in FY 2010 to provide timely technical and fiscal reporting of R&D efforts. The OTID delivered this through a structured review on a quarterly frequency that focuses on technical results and near-term plans (6-month outlook) and actual and projected cost tracking. These reviews are performed to ensure fiscally responsible execution of the program and timely identification and resolution to programmatic and technical issues.

PLANS FOR THE FUTURE

Through leveraging and collaboration within the agency at headquarters and field sites, as well as partners in other agencies and industry, and combined with a balanced portfolio of technical projects, the EM R&D Program is positioned to expand the breadth of R&D scope influencing EM baselines. Program planning in FY 2010 has delivered a program structured around flexibility, strong leadership and timely communications.

The program is positioned to deliver results in FY 2011 through real waste testing of a new waste form produced by the Fluidized Bed Steam Reforming process that would provide an option for treatment of low level waste at the Hanford site. The Office will also launch an effort to establish field research sites at several locations within the Complex in FY 2011 to provide a network of test sites and capabilities supporting groundwater and soil remediation technologies.

The R&D program will also perform the first demonstration of modeling results generated from the Advanced Simulation Capability for Environmental Management effort.

Achievements to date and future achievements are possible through a strong foundation of expertise in the program at both the staff level and those in the research community. Going forward, EM will continue to utilize this talent and strategy to solicit new ideas to very unique problems to positively impact the cost-effectiveness and timely execution of the EM cleanup mission and deliver results targeting field deployable solutions.

REFERENCES

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