Technology Development to Reduce Risks in EM – Expanded Program for FY10 and Beyond - 10401

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ABSTRACT

The mission of the Office of Technology Innovation & Development Program is to identify and advance technologies, processes, strategies, and technical practices that improve the performance and reduce the technical risk of US Department of Energy (DOE) Environmental Management (EM) projects over their entire lifecycle from planning to disposal. This paper will discuss organizational structure of the office and the technology development areas that the office currently supports.

INTRODUCTION

The mission of DOE Environmental Management (EM) is to complete *the safe cleanup of the environmental legacy brought about from five decades of nuclear weapons development, production, and Government-sponsored nuclear energy research.* This is the largest environmental cleanup effort in the world *originally* involving 2 million acres at 108 sites in 35 states. The EM program has a philosophy of *mission completion* that is founded upon ensuring the safety and health of the public and the workers, and protecting the environment.

The Department has made great progress toward safely disposing of its legacy nuclear waste (e.g., Fernald site clean-up in Ohio, the Rocky Flats site in Colorado, and the Mound site in Ohio). And, many wastes are being treated today in facilities across the DOE complex, some of which will continue to operate for many years. However, some of the more difficult challenges will be addressed by facilities that are in design or construction stages. The unique nature of the remaining challenges, many of which are one of a kind and unique to DOE, require a strong and responsive applied research and engineering program. For projects that are underway or in development, insertion of new technologies or resolving technical uncertainties or risks can dramatically reduce the cost and schedule for completion of the EM mission. The EM vision is that the engineering and technology program will provide the technical foundation for new approaches and technologies that reduce risk, cost, and schedule for completion of the project. To realize that vision, several complementary approaches are used, including strategic planning, management, and engineering innovation; partnering with public and private research and development entities; and technology development.

OFFICE OF TECHNOLOGY INNOVATION AND DEVELOPMENT

Mission [3]

The mission of the Office of Technology Innovation & Development Program is to identify and advance technologies, processes, strategies, and technical practices that improve the performance and reduce the technical risk of EM projects over their entire lifecycle, from planning to disposal. The office enlists a programmatic strategy comprised of three core elements: integrated technology development and deployment, leveraging, and engineering leadership and technical assistance.

The Office leads EM efforts to (1) develop tank waste strategies and technologies that results in an improved, optimized, and less-costly tank waste system; (2) develop strategies and technologies for groundwater and soil remediation; (3) develop strategies for the disposition of strategic, industrial, and special nuclear materials and spent nuclear fuel from within the EM complex; and (4) conduct materials and waste disposition planning and analysis.

In addition, the Office also works to reduce total cleanup costs by promoting cross-site integration, standardizing best technical practices, solutions, materials, and processes. The Office maintains a cadre of subject matter experts, who work to reduce planning, design, and construction costs and maintenance and operation costs; provide innovative transition to state of the art, beneficial technology and research and development; and leverage lessons learned and feedback. The Office encompasses three offices: (1) Office of Waste Processing; (2) Office of Groundwater & Soil Remediation; and (3) Office of Nuclear Materials Disposition.

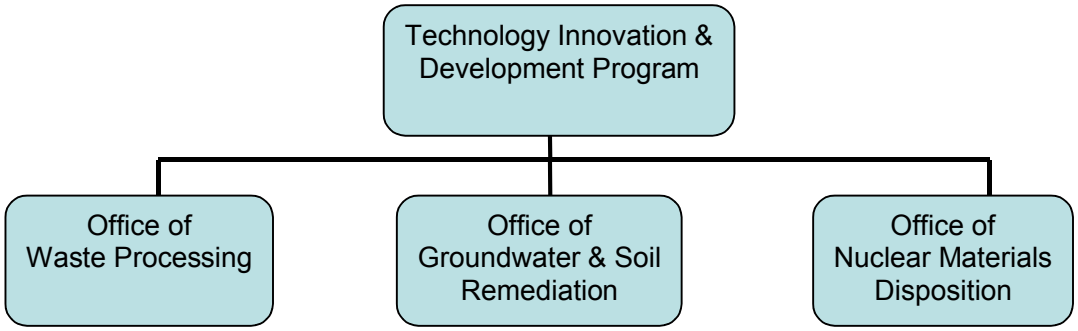

Figure 1. Office of Technology Innovation & Development structure

Office of Waste Processing

The mission of the Office of Waste Processing is to lead EM efforts to develop transformational tank waste strategies and technologies that result in an improved, optimized, and less-costly tank waste system. The office develops guidance and provides oversight of EM's waste processing operations and is responsible for the development of technology needed to address waste processing problems. It is also responsible for developing waste processing technical direction and/or assistance to sites to address difficult technical problems. This includes technical reviews and technology readiness assessments.

Office of Groundwater and Soil Remediation

The mission of the Office of Groundwater and Soil Remediation is to perform assessments, establish technical criteria and promote cross-site integration. The Office provides guidance for the development and implementation of plans for remediation of groundwater and is responsible for development of technologies needed to reduce risk from groundwater contamination. It is also responsible for providing technical direction and/or assistance to sites in resolving difficult technical groundwater and soil remediation problems.

Office of Nuclear Materials Disposition
The mission of the Office of Nuclear Materials Disposition is to perform analyses, develop and recommend program strategies for management and disposition of EM nuclear materials, spent nuclear fuel (SNF), and other surplus nuclear materials for EM. Responsibilities include developing integrated management and disposition strategy documents for surplus special nuclear material (SNM), SNF, and other surplus materials; conducting trade studies and performing life-cycle alternatives analysis; providing out-year budget integration and program planning support; and interfacing with other DOE program offices to assure integrated planning, coordination, and timely resolution of cross-cutting issues involving surplus nuclear materials.

TECHNOLOGY DEVELOPMENT AND DEPLOYMENT PROGRAM

DOE-EM established the Technology Development and Deployment (TDD) Program[1] in 2007, and focused the program on establishing multi-year technology plans to support strategic initiatives. These initiatives were outlined in the 2008 DOE-EM Engineering & Technology Roadmap [1] that guides the applied research and technology development and deployment work in the Program. The Roadmap identified six program areas: Waste Processing; Groundwater and Soil Remediation; *Deactivation & Decommissioning (D&D) and Facility Engineering; DOE Spent Nuclear Fuel (SNF); Challenging Materials; Integration and Cross-Cutting Initiatives. (The spent nuclear fuel and challenging materials programs were later incorporated into the waste processing program area.)*

DOE-EM also commissioned the National Academies of Science to review the technology program beginning in 2007, and in 2009 they published their evaluation; *Advice on the Department of Energy's Cleanup Technology Roadmap, Gaps and Bridges* [2]. The report focused on gaps, which were defined as "a shortfall in available knowledge or technology that could prevent EM from accomplishing a cleanup task on its expected schedule and/or budget". The report provided recommendations supporting the three key program areas;

- Waste Processing
- Groundwater and Soil Remediation
- Facility Deactivation and Decommissioning

For 2010, the Department restructured the technology development program to ensure focus on transformational technologies in these key program areas. This new framework is built on the foundation of this National Academies of Science report, and is addressing the identified gaps, as well as continuing responsibility for R&D to disposition nuclear materials. Briefly,

[1] TDD was the precursor to the current Technology Innovation & Development Program

"transformational" are mid- to long-term solutions and are seen as well beyond baseline projects but would radically reduce costs or schedules after implementation.

The restructured program areas are also aligned with EM's overall priorities of:

- Reducing risk while maximizing compliance with regulatory commitments
- Completing the capability to disposition tank waste and nuclear materials
- Consolidating and preparing for disposal of surplus plutonium and spent nuclear fuel
- Continued shipment of remote-handled (RH) and contact-handled (CH) transuranic (TRU) waste to the Waste Isolation Pilot Plant
- High priority soil and groundwater remediation
- Footprint Reduction

The Program targets solving technical challenges in each of the program areas: Waste Processing, Soil and Groundwater Remediation, and Materials Disposition. Deactivation and Decommissioning has been consolidated into the Office of Technical and Regulatory Support. The focus is to provide innovative solutions to the gaps, while aligned with the highest priority needs of the sites. A key aspect of this Program is support for applied engineering and research demonstrating the technical feasibility of transformational technologies. The NAS-identified gaps [1] are shown in Table 1.

Program Area	NAS Gap (priority)
Waste Processing (WP-#)	1. Substantial amounts of waste may be left in tanks/bins after their cleanout—especially in tanks with obstructions, compromised integrity, or associated piping (high) 2. Low-activity streams from tank waste processing could contain substantial amounts of radionuclides (medium) 3. New facility designs, processes, and operations usually rely on pilot-scale testing with simulated rather than actual wastes (medium) 4. Increased vitrification capacity may be needed to meet schedule requirements of EM's high-level waste programs (high) 5. The baseline tank waste vitrification process significantly increases the volume of high-level waste to be disposed (medium) 6. A variety of wastes and nuclear materials do not yet have a disposition path (low)
Soil and Groundwater Remediation (GS-#)	1. The behavior of contaminants in the subsurface is poorly understood (high) 2. Site and contaminant source characteristics may limit the usefulness of EM's baseline subsurface remediation technologies (medium) 3. The long-term performance of trench caps, liners, and reactive barriers cannot be assessed with current knowledge (medium) 4. The long-term ability of cementitious materials to isolate wastes is not demonstrated (high)
Deactivation and Decommissioning (DD-#)	1. D&D work relies on manual labor for building characterization, equipment removal, and dismantlement (high) 2. Personal protective equipment tends to be heavy, hot, and limits movement of workers (low) 3. Removing contamination from building walls, other surfaces, and equipment can be slow and ineffective (medium)

Table 1. NAS Gaps by Program Areas of the DOE-EM Technology Innovation & Development Program.

FISCAL YEAR 2010 PLANS

The current focus of the Technology Innovation & Development program is developing and implementing transformational technologies consistent with NAS recommendations. This includes input received from multiple sources, including a DOE-formed Tank Waste Integrated Project Team, and several national experts through a series of External Technical Reviews. This resulted in a refreshed program management approach and structure, revised technical portfolio, and a re-grouping of some technical work activities.

The Program funding allocation targets developing transformational technologies that can address a gap and dramatically reduce costs. The largest single cost factor in the future is the Waste Processing program area. This area encompasses retrieval, pretreatment, and immobilization of the High Level Waste. The majority of the High Level Waste is in liquid, saltcake, or sludge stored in underground steel tanks at Hanford and Savannah River. Most of the High Level Waste at Idaho National Laboratory is in the form of calcined solids, and is safely stored in bins. For retrieval, both Hanford and Savannah River have techniques for removing the bulk of the waste from the tanks, but removal of the heels is challenging. The different sites have different challenges, with Savannah River having cooling coils inside the tanks that reduce access to some areas, and Hanford having more limited riser access and leaking tanks. Both Hanford and Savannah River sites have pretreatment facilities are in the construction phase. Savannah River has a vitrification facility, a small pretreatment facility, and a low level waste disposal facility in operation. Immobilization of the pretreated wastes utilizes either a grout waste form (Savannah River), or a glass waste form (Hanford), both of which are expensive to produce and dispose. The High Level Waste fraction from the pretreatment processes is immobilized in a glass waste form, for eventual disposal in the Federal Repository. These three technology areas, retrieval, pretreatment, and immobilization, are included in the Waste Processing program area.

Environmental Management has challenging groundwater contamination problems and cleanup responsibilities, with a large number of plumes, range of hydrogeologic settings, and diversity of contaminant types. Remediation is needed on 1800 million cubic meters of soils, groundwater, and sediments in highly diverse environments that are contaminated with radionuclides, metals, and organic contaminants, sometimes in complex mixtures. Although the Department has made great progress toward safely disposing of the legacy wastes, much remains to be done. Major efforts to remediate soils and groundwater at large, complex sites such as Hanford, Idaho, Oak Ridge, and Savannah River will continue over the next decade. By 2015, DOE will be conducting long-term surveillance at approximately 120 waste sites where there is no longer a DOE mission and at about 24 sites with ongoing missions. While past accomplishments provide a guide for future success, the unique nature of many of the remaining challenges will require a strong and responsive applied research and engineering program.

The Department has incorporated Nuclear Materials Disposition as a separate Program Area in 2010. Although technology development is unfunded in FY10, the Department and reviews of the Program have recognized the increasing need to address technical challenges in the areas of spent fuel and challenging materials.

Investing in research to transformationally change the baseline plans for the High Level Waste has potential to save billions of dollars in retrieval, pretreatment, immobilization, and disposal costs. The majority of the EM-30 funds are allocated to Waste Processing to address the gaps in technology and potentially reduce costs and schedule. Investing in research to transformationally change the baseline plans for the Soil & Groundwater area also has potential to save billions of dollars in treatment and disposal costs. Selection of research areas to support is uniquely tailored to address the program area needs, and uses different criteria. Table 2 shows the NAS gap activities funded for FY10 from the Office of Technology Innovation & Development. It is expected that these Gap areas will continue to be funded in FY11 to FY12 to increase their technical maturity, and that additional Gaps can be addressed in future years.

Program Area	Funded NAS Gap (priority)
Waste Processing (WP-#)	1. Substantial amounts of waste may be left in tanks/bins after their cleanout—especially in tanks with obstructions, compromised integrity, or associated piping (high) 2. Low-activity streams from tank waste processing could contain substantial amounts of radionuclides (medium) 3. New facility designs, processes, and operations usually rely on pilot-scale testing with simulated rather than actual wastes (medium) 4. Increased vitrification capacity may be needed to meet schedule requirements of EM's high-level waste programs (high) 5. The baseline tank waste vitrification process significantly increases the volume of high-level waste to be disposed (medium)
Soil and Groundwater Remediation (GS-#)	1. The behavior of contaminants in the subsurface is poorly understood (high) 2. Site and contaminant source characteristics may limit the usefulness of EM's baseline subsurface remediation technologies (medium)

Table 2. EM-30 Funded NAS Gaps

The development of transformational technologies can have significant impact on the baseline EM Project schedule and cost. Although each innovation is unique, frequently the insertion point for the technology enables early completion of operation of a clean up, as shown in Figure 3. Baseline technology is displaced by the transformational technology, although the exact timing of insertion varies. In some cases, the new technology can be inserted after start up of operations by retrofitting the facility or changing how the clean up operation is performed. This methodology allows efficient lifecycle cost management by decreasing operational costs, disposal costs, or both.

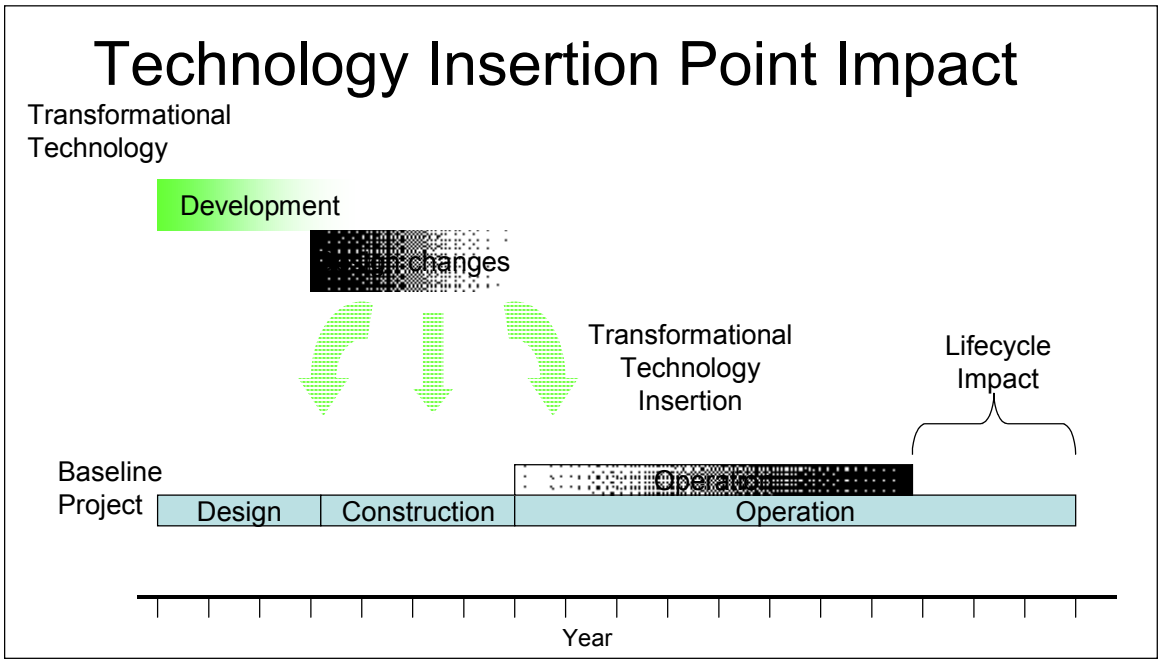

Figure 2. Technology Insertion Point Impact

CONCLUSIONS

In summary, the Office of Technology Innovation & Develop is focused on developing and deploying technologies that will transform the EM baseline into a more cost-effective and efficient system. The Office is implementing this through sound research and development, technology integration, resource leveraging and engineering leadership.

REFERENCES

1. "Engineering & Technology Roadmap Reducing Technical Risk and Uncertainty in the EM Program", U.S. Department of Energy – Office of Environmental Management (2008).
2. "Advice on the Department of Energy's Cleanup Technology Roadmap", National Research Council, National Academies Press (2009)
3. Office of Environmental Management Headquarters, Mission and Functions Statement, August, 2009