Office of Deactivation and Decommissioning and Facility Engineering Multi-Year Program Plan – 9471

Y.T. Collazo, A.P. Szilagyi, S.A. Frush
U. S. Department of Energy,
Office of Deactivation and Decommissioning and Facility Engineering
1000 Independence Ave, SW, Washington, D.C. 20585

P.G. Kirk
Oak Ridge National Laboratory
P.O. Box 2008, Oak Ridge, TN 37831

ABSTRACT

The objective of the U.S. Department of Energy's (DOE) Environmental Management (EM) Engineering and Technology Program is to reduce technical risk and uncertainty in the Department's cleanup programs and projects[1]. To reduce those risks and uncertainties the Program will provide technical solutions where none exist, improved solutions that enhance safety and operating efficiency or technical alternatives that reduce programmatic risks (cost, schedule, or effectiveness).

The Office of Deactivation and Decommissioning (D&D) and Facility Engineering (D&D Program) supports this objective. A main thrust of the D&D Program effort focuses on innovative application and timely insertion of existing commercially available technologies, processes and hardware systems to address the identified D&D risks and challenges. This is accomplished by adapting, modifying (for site-specific requirements), optimizing (for assured safety, better efficiency and lower cost), and demonstrating existing technologies and hardware to produce sufficient technical data and operating parameters to allow the site D&D operators to insert these technologies into their baseline operation with confidence.

INTRODUCTION

EM's second highest cost center is in the area of D&D at an estimated $20-30 Billion. EM's current life-cycle scope comprises almost 5000 facilities, including over 1000 nuclear and radioactive buildings[2]. 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. Historically, D&D activities have received a lower priority ranking than areas such as high-level waste (HLW) processing, due to key factors: (a) out year schedules, for most D&D activities lack regulatory drivers thus influencing the priority of funding allocated to D&D technology development; (b) multi-year constrained risk-based funding profiles; and (c) the lack of appreciation for the difficulty of dealing with highly complex, highly contaminated, and often "one-of-a-kind" D&D challenges.

[1] U.S, Department of Energy, Office of Environmental Management, Engineering and Technology Roadmap, March 2008
[2] Mark Gilbertson, Presentation of Waste Management Symposium, Phoenix, Arizona, February 2008

To directly support opportunities identified in the EM cleanup initiatives, the D&D Program's Multi-Year Program Plan (MYPP)[3] is aligned and driven by site cleanup priorities and corresponding technical needs at DOE's major cleanup sites: Savannah River (SR); Idaho (ID); Office of River Protection (ORP)/Richland Operations Office (RL), Portsmouth and Paducah Project Office (PPPO), and Oak Ridge (OR)—as well as at the smaller sites at West Valley (WV) and Brookhaven National Laboratory.

A large majority of the facilities to be remediated in the DOE Complex, that are reflected in the site technology needs statements, are one-of-a-kind and/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-EM needs. With the more complex D&D projects scheduled into the out years an opportunity exists to address needed technical improvements and advancements if EM hopes to achieve cost and schedule expectations.

Today, the common perception for most of EM's D&D activities is that the D&D of industrial and low-level radiological facilities can be completed with relatively few new technical approaches or innovative technology insertions. However, good stewardship requires further evaluation to determine whether these activities can be conducted in a safer and more cost effective and efficient manner. Step improvements in technical approaches and in innovative technology can lead to greater enhancements in worker safety while offering improved D&D operational schedules with reduced cost profiles.

MAJOR TECHNICAL RISKS AND UNCERTAINTIES

Risks are known technical issues that could prevent project success. Uncertainties are indefinite or unpredictable technical aspects of a project. The major technical risks and uncertainties identified by Office of D&D and Facility Engineering are as follows.

- The extent of facility deterioration and contamination throughout the complex is not fully understood, leading to uncertainties in programmatic requirements. Improved information acquisition and management, and advanced characterization strategies are required to better define and manage requirements for facility maintenance and decommissioning.
- Facility deterioration and/or high radiation levels preclude safe entry by personnel, necessitating the development and deployment of adaptable robotic and remote data acquisition platforms. Demolition of such facilities requires similar technologies for disassembly and size reduction.
- Identifying the quantity and location of radioactive and hazardous chemical contamination, and control and containment of contamination during decommissioning and demolition of facilities requires improved technologies and processes.
- Technologies to select and achieve the most appropriate and protective end states for facilities are needed to advance defensible strategies for facility decommissioning.

A National Research Council report[4] identified four broad areas of research where technologies could make significant contributions to solving D&D problems, decreasing lifecycle costs, and improving safety performance, including: 1) Characterization of contaminated materials; 2) Decontamination of equipment and facilities; 3) Remote intelligent systems; and 4) End state definition for facility D&D. The DOE Research and Development (R&D) Portfolio – Environmental Quality[5] report indicates that "site problem holders for facility D&D activities have identified 180 active needs that must be met to accomplish the current baseline". The broad categories of problem areas/needs identified generally match

[3] U.S. Department of Energy, Office of Engineering and Technology, Applied Research and Technology Development and Deployment, Integrated Multi-Year Program Plan (FY 2008 - FY 2010) March 2008
[4] National Research Council Report: *Research Opportunities for Deactivation and Decommissioning Department of Energy Facilities*, 2001
[5] *DOE Research and Development Portfolio, Volume II, Environmental Quality,* February 2000

those recommended by the National Research Council, with added specificity (e.g., underwater characterization related to spent nuclear fuel pools and remote/robotic capabilities for hot cells/glove-boxes), and the inclusion of technology needs related to D&D of reactors and entombment end states.

STRATEGIC APPOACH

The D&D engineering and technology investment strategy is linked to EM's mission priorities as reflected in the Site Performance Baselines, corporate performance measures, Performance Management Plans, Risk Management Plans, and defined end-states. The EM sites have identified technical gaps in their cost and schedule baselines, which if resolved can offer significant improvements to current baselines and safety performance for both workers and the public. EM's challenge is to identify alternate technologies or technical approaches that will serve as "forcing functions" or "transformational advancements", impacting the baseline schedules or having significant potential for changing the dynamics of site D&D work scope.

Strategic investments are also made in the development of novel, innovative technologies to address unique site D&D challenges and enable site cleanup. These are high cost, high risk projects where a transformational change is necessary to enable improved D&D performance.
The MYPP creates a logical case and vision for federal government investments in technology development and deployment, technical assistance, and applied research, focusing on three major goals: 1) reducing technical and safety risks in current site baselines; 2) reducing costs by accelerating cleanup; and 3) anticipating and providing early awareness of alternative technologies and practices for disposal pathways that are subject to uncertain regulatory outcomes. Technology alternatives, technical assistance, and applied research activities must deliver a return on investment and be compatible with existing facilities and infrastructure at the sites.

The D&D strategy recognizes that many facilities will be maintained in a surveillance and maintenance phase until appropriate levels of funding are made available to pursue deactivation and decommissioning work scope. The Office of D&D and Facility Engineering works with the site Federal Project Directors, project managers, and others to identify opportunities to insert new and improved D&D technologies that could potentially accelerate schedules so that long-term surveillance and maintenance costs can be avoided or minimized.

The Office of D&D and Facility Engineering is taking a corporate and holistic strategic approach to increasing technical understanding and reducing the technical risk and uncertainty of EM programs and projects by providing identification and advancement of alternative technologies, technical assistance, and lessons learned and best practices, combined with multi-disciplinary services of engineering consultation, guidance, expertise, and policy development. Our overarching goal is to improve planning, design, construction, and facilities and infrastructure management activities for D&D activities at the sites. A key element of this approach is working with the site Federal project directors, project managers, and prime contractors to identify technical needs, priorities, and gaps and, most importantly, to estimate the benefits, costs, and time frames of the technologies and technical approaches selected for investment.

Alternative technologies must be delivered in time for implementation during the life-cycle of a site cleanup schedule. For those technology needs and priorities identified by the sites, but not addressed by the prime contractors, EM-complex priorities and funding profiles are established for the out years. Cleanup technologies are often developed at national laboratories, universities, other academic institutions, and commercial providers through a competitive bidding process. The technology must stand on its own merits, be safe, cost effective, and offer significant and desired advantages over other approaches without introducing unacceptable technical risk. Although technical needs will exist until cleanup is completed in the future, specific, long-term technology planning becomes more difficult due to

uncertainty of cleanup progress, delays with design and construction of already approved facilities/plants, and uncertain regulatory outcomes for certain disposal pathways.

The Office of D&D and Facility Engineering also provides technical assistance to sites to reduce the technical uncertainty and risk of site cleanup. It provides rapid response to address current technical problems impeding site cleanup that will result in significant cost savings or have a major improvement to the waste disposition pathway. Most importantly, a key component of this assistance is providing engineering and scientific expertise for External Technical Reviews to address difficult technical problems or for resolution of project management issues. Technical assistance includes activities such as: baseline and project reviews; technical workshops with experts on specific crosscutting issues; engineering consultation; site troubleshooting;; scientific or engineering problem solving;; technical analysis and studies; assistance with technology demonstrations; mockups; testing of alternative approaches; technical transfer and integration activities for the complex; and contract and acquisition support.

The development, implementation, and execution of EM's investments in applied research are accomplished through partnerships between the EM Program and DOE's Office of Science (DOE/SC) and National Laboratories. Despite a decrease in funding for EM technology activities over the past five years, critical core competency remains at several major laboratories closely associated with larger EM sites – Savannah River National Laboratory (SRNL), Idaho National Laboratory (INL), Oak Ridge National Laboratory (ORNL), and Pacific Northwest National Laboratory (PNNL). The Office of Engineering and Technology is working with the National Laboratories to develop an enduring EM R&D and Applied Science and Technology Program with a goal of reducing closure project risk and uncertainty. The three major components of this program are people, programs, and infrastructure. A lasting investment in the National Laboratory complex will ensure maintenance of core competencies and technical baseline for the long-term EM mission.

In addition, a critical aspect of increasing our technical understanding in D&D is working with the national laboratories and universities to identify critical and emerging issues and needs, analyze technical gaps, conduct applied research, and provide long-term oversight and guidance. There is also considerable D&D expertise residing in other Federal agencies, the commercial sector (nuclear utilities and commercial D&D contractor firms), and the international community. One of the key objectives in the MYPP is to partner with these organizations to exchange lessons learned and best practices, identify subject matter experts, and/or to develop a leveraged applied research program that meets the technical needs for the sites.

Development of strategic initiatives for the D&D Program is directly linked to EM's mission priorities at the sites. In July and August of 2008, the Office of D&D and Facility Engineering held workshops to prioritize EM's D&D technical needs and the supporting technology projects. Participants included representatives from EM HQ and field sites (both federal and contractor staff), academia, National Laboratories, and industry. A structured prioritization process developed and facilitated by Cogentus, Inc. was used to understand the magnitude, technical complexity, and intra- and inter-site linkages of D&D challenges across the DOE-complex and to evaluate and rank potential technology projects. The results of this workshop guided the selection and funding of the FY 2009 D&D development and demonstration projects.

STRATEGIC INITIATIVES

The D&D Program concentrates on three strategic initiatives: 1) Characterization, 2) Deactivation, Decontamination, and Demolition, and 3) Closure.

Characterization

The Characterization Initiative is focused on developing and deploying improved characterization and monitoring technologies for detecting and quantifying penetrating radiation and other hazardous materials. In FY 2009 efforts will include demonstration of remote characterization technology that facilitates remote mapping and characterization of hazardous facilities or areas within a hazardous facility. Building upon the lessons learned from a demonstration at Savannah River Site in September 2008, ORNL will deploy a robotic platform coupled with a three dimensional laser imaging system and/or characterization tools in a structurally deteriorated facility or specific area within a facility that is deemed unsafe or at high risk for human entry. The demonstration will provide high resolution images of visible structures within a facility that can be imported into standard Computer Aided Design packages to produce as built engineering drawings of the hazardous facilities or areas without putting workers at risk. These images coupled with characterization data obtained from the remote sensing technologies will help project engineers plan the work to be performed in these hazardous facilities/areas more safely and cost effectively.

A second characterization project planned for FY 2009 will develop a conceptual design for non-destructive assay (NDA) check standards. There is a need by the DOE EM D&D projects at the Portsmouth and Paducah Gaseous Diffusion Plants to develop a standardized method and process for performing NDA. The current approach utilizes field radiation measurements, adjusts for geometry and equipment configuration, and calculates the quantity of residual radioactive material remaining inside process equipment after shutdown.

As part of the standardization process, a quality systems program regulating NDA programs is being drafted. The quality systems program will require the use of NDA performance evaluation check standards to confirm program performance objectives are being achieved. These check standards will simulate radioactive material quantity and configurations commonly occurring within the gaseous diffusion plant process equipment. Similar check standards are in use at sites that process transuranic waste.

The check standards required for NDA programs simulate the geometry of radioactive material that is known to internally self-shield the emitted radiation that is being measured. In addition, these check standards need to be of a chemical composition similar to the radioactive holdup material being measured. This project will research the location and geometry of residual radioactive materials in the Portsmouth and Paducah Gaseous Diffusion Plants and develop the conceptual design for various check standards required for the NDA quality assurance program. A manufacturing cost estimate, schedule, and conceptual design for the standards will be developed.

Process knowledge encompasses the history of operations and activities conducted within a facility and can be vital to efficient and cost-effective characterization of facilities slated for D&D. When properly captured process knowledge can be instrumental in defining the scope of a D&D project. In FY 2009 a project to survey the DOE facilities to determine the current status of, and approach to, the development and retention of facility process knowledge will be completed. Additionally, other federal agencies with comparable issues will be evaluated to determine whether approaches used in those agencies can be leveraged to improve the practices within DOE. The current practices in the acquisition and maintenance of process knowledge at various EM-sites will be evaluated. As a component of this overall activity, D&D operations personnel will be engaged to identify those elements of the overall suite of process knowledge that are most critical for improving efficiency and safety, and minimizing project cost and schedule uncertainties. The goal of this project is to identify the current Best Practices for facility process knowledge at various EM sites and develop a tailored set of Best Practices Elements that should be captured for all facilities in the DOE Complex that are being deactivated.

Given the pervasiveness of asbestos in older facilities and the potential respiratory hazard posed by asbestos and beryllium, a significant safety improvement opportunity exists in the development of innovative technology to detect and/or passivate asbestos and beryllium. In FY 2009, EM-23 will conduct a project to define the fundamental types of contaminant releases and detection principles and determine selection and evaluation criteria; identify available and alternative approaches by contaminant; and establish design review criteria.

Deactivation, Decontamination, and Demolition

The Deactivation, Decontamination, and Demolition Initiative is focused on 1) developing and deploying improved deactivation, retrieval, size-reduction, and stabilization technologies that provide adequate personal protections and effectively achieve end-state requirements; and 2) developing and deploying advanced remote and robotic methods to rapidly access and assay facilities to determine optimal D&D approach. In FY 2009 efforts will include demonstration of advanced technologies for repetitive drilling in concrete structures. Placement of grout for in-situ decommissioning actions necessitates the drilling of grout insertion and air venting holes in thick, reinforced concrete structures. Structures at Savannah River are up to 5 feet thick concrete with heavy rebar reinforcement – likely running in a two-to-three dimensional matrix. Six inch diameter holes (perhaps larger) will be needed for grout placement and venting in sub-grade spaces. Currently this is a labor intensive activity using hand held drilling equipment, resulting in extended schedules and in the potential for stress and injuries to personnel. Alternative, stand alone equipment capable of drilling through these structures is needed to reduce human exposure (e.g., noise, vibration, physical impact) and to conduct these tasks more expeditiously. It is envisioned that a commercially available coring machine, either self standing or used in combination with a commercially-available platform or tracked vehicle and potentially coupled with remote capabilities will be designed with appropriate interfaces.

A second project will target the D&D of highly contaminated hot cells. The process of characterizing the internal radiological conditions and subsequently initiating equipment, machinery, glove-box, pipeline, ventilation duct, and other material removal actions from highly contaminated hot cells is a slow, meticulous, and high risk activity based on the fact that direct human interface is necessary. The development of low cost, semi-disposable robotic platforms with multiple capability task attachments and remote-intelligent interfaces would significantly reduce worker exposures, cost, and schedule.

The Plutonium-Uranium Extraction (PUREX) plant at Richland incorporated a unique feature for disposing of large pieces of radioactive solid waste, such as failed or excess equipment. A 500-foot tunnel was built onto the single-track rail tunnel used to bring irradiated slugs to the east end of the PUREX building. Expendable rail cars were used to push intensely radioactive equipment up the tunnel for disposition. In 1964, a 1,500-foot tunnel was constructed after the first tunnel became full. EM-23 will undertake a project in FY2009 to collect and analyze existing information regarding the history and status of the PUREX tunnels, identify critical data gaps, and identify approaches and methodologies. Potential applicable existing technologies to characterize and de-inventory the PUREX tunnels and other large structures will be identified to eliminate technical barriers and uncertainties, to reduce the life-cycle resources required for high-cost, high-risk work, and to improve safety performance by applying improved/new technology.

A fixative/fogging project will focus on the demonstration of fixatives/fogs and specialized delivery systems for hot cells, ventilation systems, or other systems/structures. The D&D of radiological or nuclear facility requires that the process systems and structures within the facilities be cleaned and stabilized to allow demolition to occur while maintaining worker radiation exposure as-low-as-reasonably-achievable and without spreading radioactive contamination. One decontamination step

typically consists of applying a fixative coating (or similar material) to contaminated process systems and surfaces within the facility, such as hot cells and ventilation systems, to hold contamination in place during demolition. Building upon the lessons learned from the cold demonstration at Florida International University in November 2008, ORNL will apply one or more fixatives and/or fogs to one or more contaminated hot cells and/or their ventilation ducts in an inactive facility at ORNL. The performance of the fixative/fog and delivery system will be evaluated based on specified criteria and the results used to guide future decommissioning activities.

In addition to fixatives, another class of materials can be used as removable decontamination agents. Similar to applying a fixative, decontamination gels can be applied (painted, sprayed, etc.) to contaminated surfaces, allowed to dry (typically overnight) and removed along with a high percentage of the original contaminant. The first pilot demonstration of a decontamination agent at Oak Ridge will use Decon Gel manufactured by Cellular Bioengineering Inc. The site for this demonstration will be a ~40'X40' area behind Cell 1 in Building 2026. The area was flooded when a LLLW pipe became clogged. The contaminated medium is concrete. The main contaminants of concern are uranium and plutonium. Radiological levels are in the 1,000,000 dpm range. The area is routinely sprayed to keep reduce airborne contamination.

The Savannah River Site is planning the decommissioning of facilities at which plutonium-238 was processed to support the National Aeronautics and Space Administration's deep space missions. Processing operations occurred in glove-boxes and hot cells, which became contaminated with the nuclear material. Significant portions of the contamination are known to occur as small particles in the range of a few microns to submicron in size. The relatively short half life, high energy, and small size of these particles presents unique challenges for decontamination relative to methodologies that have previously been used for decontamination of plutonium handling facilities. A set of initiatives is being pursued to develop and validate approaches that will achieve the decontamination objectives, while minimizing risk to workers and potential spread of contamination.

The greater the time between facility abandonment and demolition the greater the total cost of surveillance and maintenance. In an ideal world once a facility was declared excess it would move quickly through deactivation, decommissioning, and demolition. In reality, given budget constraints, it is often 10-20 years or more between abandonment and demolition. Since all sites have finite budgets, priorities must be set and money invested in surveillance and maintenance takes away from funding of remedial action and D&D activities further delaying final disposition. Without an adequate investment in surveillance and maintenance the facilities can deteriorate to the point they are unsafe for human entry and potentially increase the cost of D&D. The challenge facing DOE EM Federal Project Directors is how to exercise responsible stewardship in balancing the investment in surveillance and maintenance with the safety issues and final cost of D&D. To this end EM-23 has developed a Multi-Criteria Decision Model for Surveillance and Maintenance Investment Decisions to help prioritize surveillance and maintenance activities needed to avoid costly surprises during D&D of a facility. The model is available on the EM-23 Knowledge Management Information System and subject matter experts are available to help with using this tool.

EM-23 is also developing standardized and user friendly tools designed to enhance the performance of D&D projects across the complex. The D&D Risk Management Evaluation and Work Sequencing Standardization Project is developing practical risk-management tools, such as (1) computer-based models that evaluate site-specific parameters in order to optimize sequencing of work, (2) standard electronic checklists for hazard identification and categorization, particularly as appropriate for industrial hygiene and health physics approval, and (3) "cheat cards" for recommended Final Status Survey (FSS) instrumentation to confirm the successful completion of decontamination. These tools can be used by

DOE project managers to enhance D&D project performance and can also be used in Argonne National Laboratory's ongoing series of Decommissioning Courses.

Closure

The Closure Initiative is focused on developing the technologies and technical approaches for achieving informed end-state strategies and conditions to satisfy federal, state, and local stakeholders. In FY 2009 efforts will include support for In Situ Decommissioning (ISD) (Entombment). A comprehensive and well thought-out approach is needed to identify the most urgent technology challenges and concomitant technical solutions for the implementation of ISD. The work will be initiated by conducting a workshop during FY09 to identify technology needs at SRS and across the DOE complex. The results of the workshop will be documented in a report along with the identification of significant technology needs. Following the workshop, a strategy will be developed to address these technology needs for implementation in FY09-12.

SUMMARY

The mission of the Office of D&D and Facility Engineering is to develop, demonstrate and facilitate the implementation of innovative technologies and approaches which result in safe, cost-effective, and timely D&D of DOE facilities. The vision is to become the 'best-in-class' D&D engineering and technology program through the provision of technical assistance, technology development, and applications engineering support to reduce technical risks and uncertainties to complete the EM mission. This goal is being accomplished through the implementation of strategic initiatives targeted at addressing the highest priority technical problems at DOE sites. The success of this program could have a substantial impact on the safety, cost-effectiveness and timely execution of D&D projects across the Complex.