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Environmental Management Science Program for D&D

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D&D Focus Area (DDFA) Mid Year Review

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Introduction

The Environmental Management Science Program (EMSP) was established in 1996, when Congress directed the Department of Energy (DOE) to "provide sufficient attention and resources to longer-term basic science research which needs to be done to ultimately reduce clean-up costs, …develop a program that takes advantage of laboratory and university expertise, and…seek new and innovative clean-up methods to replace current conventional approaches which are often costly and ineffective." To help satisfy this request, the EMSP was formed. The EMSP has sections that support major problem areas in DOE, including: high-level waste, transuranic and mixed waste, subsurface contamination, deactivation and decommissioning, spent nuclear fuel, nuclear materials, and ecology, health and risk. This paper focuses on the deactivation and decommissioning (D&D) section of EMSP.

The mission of the EMSP is to develop and fund targeted, long-term research programs that will result in transformational or breakthrough approaches for solving DOE's environmental problems. The purpose of this research is to provide the basic science knowledge that will lead to reduced remediation cost, schedule, technical uncertainty, and risk.

Organizationally, the EMSP is a collaborative effort among the DOE Office of Environmental Management (DOE-EM), Office of Science (DOE-SC), and the Idaho Operations Office (DOE-ID). DOE-ID is the lead field office responsible for assisting Headquarters with implementation of the EMSP by providing technical oversight, procurement services, and technical integration. The Idaho National Engineering and Environmental Laboratory (INEEL) provides technical support to DOE-ID in implementation of the EMSP. The EMSP D&D program works closely with the D&D Focus area, the D&D Lead Laboratory at Oak Ridge National Laboratory (ORNL), and the Robotics Cross Cut program to ensure an integrated approach across DOE. Sue Whited is the DOE-ID EMSP D&D Program Manager who provides oversight and guidance. Ann Marie Phillips is the INEEL EMSP D&D technical lead, whose role is to facilitate transition of EMSP research projects into D&D Operations at the INEEL and other DOE sites.

The DOE-ID and the INEEL are well suited to their roles in EMSP. The INEEL has had a very active D&D program for over 25 years, resulting in successful decommissioning of over 100 structures with no significant accidents of safety incidents. This active D&D program has given INEEL employees an in-depth knowledge of D&D practices, and provides an ample number of end-users for D&D technologies. In addition, the INEEL has completed several very successful Large Scale Demonstration and Deployment (LSDDP) and Accelerated Site Technology Deployment (ASTD) projects in recent years.

These projects have given the INEEL team experience in development of technologies and in transitioning technologies from the laboratory to D&D operations. It has also provided an in-depth understanding of D&D needs.

Relevancy

The second thrust for Environmental Management (EM) addresses alternative approaches to current high risk and/or high cost baselines in order to accomplish EM clean-up at reasonable cost and with reasonable schedules. The EMSP is relevant to this thrust because it is doing the long-term research needed to develop technologies and approaches to replace the baseline methods. This research is directed at DOE documented D&D needs. In addition, EMSP research is relevant to our nation, because it is innovative research that will provide sound technical knowledge to keep our nation a scientific leader.

Throughout the DOE complex, there are numerous surplus buildings that require D&D. In most cases, technologies exist that can be used to perform this D&D, but many of these are inefficient, cumbersome, or involve risks that could be reduced. New technologies or methods are needed to complete the D&D of these facilities in a safer, cost effective, and timely way with less risk to workers or the environment. In many cases, these technologies do not exist because the scientific basis for them has not been developed or proven. Long-term research and increased scientific knowledge are required to develop new technologies or methods to perform this work more efficiently. Many DOE sites across the nation will require D&D to meet their clean-up milestones over the next years. In order to do this required clean-up, we need to start early to develop technologies that can be used to perform D&D tasks more efficiently. The EMSP is doing the relevant scientific research needed to develop technologies to complete this clean-up.

The EMSP is focused on developing technologies to achieve the second EM thrust by doing work that is directed at solving documented, relevant DOE needs. These documented needs include specific needs identified by each DOE site through the Site Technology Coordination Groups (STCGs), and broad, complex-wide needs that are identified through independent studies, such as those conducted by the National Academy of Science (NAS). EMSP uses these documented needs to define the requirements when they solicit new research grants. This directs the energy of national laboratories, universities, and private industry toward solving DOE's needs and ensures that the research performed is relevant to upcoming D&D work within DOE.

Technical Approach

The technical approach of the EMSP program focuses research on developing improved technologies and methods to replace the current high risk and high cost baseline technologies described in EM's second thrust area. To do this EMSP first defines the needs, then requests proposals directed toward meeting those needs. Once research grants are awarded, the EMSP technical lead acts as a liaison between the researchers and problem holders to help transition the research into field operations.

The EMSP uses STCG defined site needs and the needs identified by independent studies as the basis for their solicitations. Throughout DOE, STCGs have identified 181 D&D science and technology needs, and if remote systems and robotics needs are included, the total rises to 263. In addition, the National Academy of Science report written in 2001 identified four important needs for D&D development within the DOE complex. These general needs align with and support the more specific STCG needs. The four need areas are:

- Characterization of contaminated materials
- Decontamination of equipment and facilities
- Remote intelligent systems to improve worker safety
- End state definition for facility D&D.

The EMSP used the first three of these needs, characterization, decontamination, and remote systems, as the basis for the 2001 EMSP solicitation for D&D proposals. The fourth needs, end state definition, was not included in this solicitation because it is more of a policy issue and may be covered under programs such as Long Term Stewardship. As a result of this directed solicitation, EMSP awarded 13 new D&D research grants that address the DOE need areas defined by the NAS study. Five of the new projects address characterization needs, three support decontamination, and five focus on robotics issues. Additional details on the new awards will be covered in the Technical Progress section of this paper. Through these directed solicitations, EMSP focuses the attention of Universities, National Laboratories, and private industry on solving the most significant D&D problems within DOE.

Ultimately, for the EMSP to be successful, research projects need to be applied in field operations at DOE sites. This transition is often surprisingly difficult. This is partly because the researchers are not familiar with the field operations needs, do not have direct contacts with the people who need help, and do not have research results that are ready or mature enough to easily transfer to the field.

EMSP technical leads aid with this transition by acting as the interface between problem holders and researchers. In this role, technical leads provide more direct contact with the researchers and guide them to think about what the end result of their research will be and how it will be used. As the technical leads work with the researchers throughout their project, they help them understand the DOE needs and connect them with the problem holders so they can develop products that are directly applicable to DOE needs. In addition, technical leads cross-link EMSP projects to STCG needs through the research cycle. They contact problem holders to learn about their needs and inform them about EMSP projects that will help solve their problems. Technical leads then work to set up meetings between problem holders and researchers to discuss how the research can be applied to the problem holders' needs. Finally, technical leads help set up and coordinate field demonstrations of EMSP technologies. In this way, technical leads are working to help the research projects result in useful, practical products for use in D&D operations. The resulting improved technologies and approaches will help complete D&D of DOE facilities in a faster, less expensive, and safer way.

Benefits

The EMSP will provide significant benefits to DOE as it performs the D&D activities required to meet its clean-up milestones. These benefits will spill over into private industry and benefit the nation, too. In addition, having the DOE-ID and the INEEL act as the EMSP lead lab provides benefits to the EMSP. Lastly, the INEEL EMSP supported development of an ASTM Standard Guide that will provide benefits to many who are trying to transition technologies from the laboratory into field applications.

EMSP's approach of awarding research grants directed at solving documented DOE needs will provide benefits to DOE as it will result in development of improved technologies and approaches that are directly applicable to the most significant D&D problems that DOE faces. The current technologies do not meet DOE's long-range needs for difficult D&D problems and do not allow the work to be completed as cost effectively, quickly, and safely as needed. The EMSP will help solve problems in decontamination, characterization, and remote systems. For example, one EMSP researcher is investigating ways to decontaminate radioactively contaminated metal by removing transuranic elements with an atmospheric-pressure plasma. Another is investigating the ways radionuclides transport through and are bonded to concrete, so improved concrete decontamination methods can be developed. Numerous EMSP projects are looking into increasing robotics capabilities, which will remove workers from dangerous work areas and increase safety. In many ways such as these, the improved technologies and approaches resulting from EMSP research will provide significant benefits to DOE, as they will help complete D&D work in a faster, cheaper, and safer way. This will help DOE meet its clean-up milestones within budget.

In addition to providing benefits to DOE, the EMSP research will help private industry, both in nuclear power plant decommissioning and in other areas. The new technologies resulting of this research are likely to be applied to D&D of commercial nuclear power plants. As they are used to complete D&D activities at DOE facilities, they will naturally transition to commercial nuclear reactor decommissioning as well. The EMSP and other DOE programs aid in this transition by publicizing information at conferences and through other communication channels. Using the new methods to perform commercial nuclear power plant decommissioning will benefit the U.S. taxpayers, power users, and economy. It is also likely that the basic scientific research will spin off into other areas and uses outside D&D, benefiting our society even further.

The benefits of EMSP to the nation, although difficult to measure, are very significant. Funding basic research such as the EMSP helps build the U.S.A. as a technology based society and strengthens the science infrastructure of our nation. It helps position the nation to lead the world in better technologies and improved environmental management and clean-up. Many of these technologies will transition into other areas, including National Security, Defense, new business, and foreign opportunities. These will have long-lasting benefits to our country.

DOE-ID and the INEEL provide benefits to the EMSP and aid in its success through their experience and capabilities. The INEEL team has over 25 years of D&D Operations

experience, and has completed D&D of a large variety of structures and facilities. They are considered one of the leaders in the D&D field, and are requested to teach classes, sit on national committees, facilitate conference workshops, and consult internationally. The INEEL also has a strong background in technology development, and is familiar with what it takes to get products into use in operations. The INEEL has currently active LSDDP and ASTD projects that are compatible with EMSP work. These projects provide the opportunity to demonstrate and deploy EMSP technologies while sharing part of the cost burden for these tests. The INEEL has a currently active D&D program in which to "try out" new technologies and a large variety of facilities requiring D&D. Lastly, the INEEL STCG has a well-defined set of documented INEEL D&D needs. All of these factors allow DOE-ID and the INEEL to provide significant benefits to the EMSP program and its success and make them ideal to the role as the EMSP lead laboratory.

Because the transition from basic science to field operations is so difficult, the INEEL EMSP encouraged initiation of and wrote an American Society for Testing and Materials (ASTM) Standard Guide to help transition projects from the laboratory to the field. This document outlines the steps in progressing from laboratory to field and delineates the items that should be completed at each step in this process. The draft *ASTM Standard Guide for Transitioning Basic Science into Commercial Technologies* is currently undergoing reviews and revisions by the ASTM committee, and it is hoped it will be published in 2002. This document will benefit many technology developers nationwide as they transition technologies from the laboratory into field applications.

Technical Progress

In FY 2001, the EMSP sent out a solicitation for D&D proposals to address the NAS identified D&D needs. Thirteen new awards for D&D EMSP projects were granted based on this solicitation. As a result of the focus on D&D needs, all 13 of the selected projects address one or more of the NAS identified need areas. These projects, along with the Principal Investigator and other information, are shown in Table 1. Five of the new projects address characterization needs, five address robotics issues, and three address decontamination. EMSP grants have a duration of three years. Four of the projects listed in Table 1 are renewals, and are marked with an asterisk. One of these marked projects (Dr. Hicks) was renewed FY 2000, so the table lists a total of 14 current EMSP D&D projects. Additional information about these projects, and about the EMSP in general, can be found at the website: http://emsp.em.doe.gov/

Table 1. Current EMSP D&D Projects. * Renewal Projects

Project Number	Title	Principal Investigator	Institution	Problem Area
82773 *	Contaminant-Organic Complexes: Their Structure and Energetics in Surface Decontamination Processes	Ainsworth, Dr. Calvin C.	Pacific Northwest National Laboratory	Characterization
82803	Novel Laser Albation Technology for Surface Decontamination	Chen, Dr. Chung H.	Oak Ridge National Laboratory	Decontamination
82807	Physico-Chemical Dynamics of Nanoparticle Formation during Laser Decontamination	Cheng, Dr. Meng-Dawn	Oak Ridge National Laboratory	Characterization/ Decontamination
82873	Design and Sensor-Based Control for Hyper-Redundant Mechanisms	Choset, Dr. Howie	Carnegie Mellon University	Robotics
82749 *	Field Portable Microchip Analyzer for Airborne and Surface Toxic Metal Contaminants	Collins, Dr. Greg E.	Naval Research Laboratory	Characterization
82797	Image-Based Visual Servoing for Robotic Systems: A Nonlinear Lyapunov-Based Control Approach	Dixon, Dr. Warren E.	Oak Ridge National Laboratory	Robotics
82723	Remote Manipulation for D&D Exhibiting Tele-Autonomy and Tele-Collaboration	Ewing, Dr. Thomas	Argonne National Laboratory	Robotics
73835 *	Atmospheric-Pressure Plasma Cleaning of Contaminated Surfaces	Hicks, Dr. Robert F.	University of California, Los Angeles	Decontamination
82810	Hybrid Actuators for Enhanced Automation in D&D Systems Tasks	Jansen, Dr. John F.	Oak Ridge National Laboratory	Robotics
82794	Multi-Optimization Criteria-Based Robot Behavioral Adaptability and Motion Planning	Pin, Dr. Francois G.	Oak Ridge National Laboratory	Robotics
82715	Development of Biodegradable Isosaccharinate-Containing Foams for Decontamination of Actinides: Thermodynamic and Kinetic Reactions between Isosaccharinate and Actinides on Metal and Concrete Surfaces	Rai, Dr. Dhanpat	Pacific Northwest National Laboratory	Decontamination
82799*	Bio-Chemo-Opto-Mechanical (BioCOM) Sensors for Real-Time Characterization	Thundat, Dr. Thomas G.	Oak Ridge National Laboratory	Characterization
82784	Assessing the State and Distribution of Radionuclide Contamination in Concrete: An Experimental and Modeling Study of the Dynamics of Contamination	Viani, Dr. Brian	Lawrence Livermore National Laboratory	Characterization
82792	Alternative Ionization Methods for Particle Mass Spectrometry	Whitten, Dr. William	Oak Ridge National Laboratory	Characterization

Following the award of new research projects from a solicitation, a "kick-off" meeting is usually held to foster communication between researchers and site problem holders. For the FY 2001 D&D awards, a Kick-off workshop was held at Oak Ridge, TN, on November 27th and 28th, 2001. The workshop was particularly successful because, through guidance from the EMSP team, the researchers focused their presentations on the end results of their research and how it will be useful to DOE. In addition, they discussed what they need from EMSP, DOE, and DOE sites to assist them with transitioning into use in D&D operations. Combined with this, several end-users from DOE sites attended and presented their site D&D needs, and gave feedback to the researchers on their research projects. This gave the researchers insight into upcoming needs for D&D work, and opened the door for future collaborations. By establishing communication and contacts early in the research cycle, it is hoped that the results of the scientific research can be effectively applied to D&D needs.

The EMSP is doing research that is relevant to DOE's D&D needs, and will provide significant benefits to DOE by developing improved D&D technologies. All of the 14 currently funded EMSP D&D projects have great potential to help solve DOE's D&D problems. With EMSP's continued support of these projects and assistance with their transition into the field, we will find solutions to D&D problems and see significant reductions in cost, schedule, and risk.