Office of Science
Notice 01-19

Environmental Management Science Program: Research Related to Deactivation and Decommissioning Issues

Department of Energy
Office of Science and
Office of Environmental Management

Office of Science Financial Assistance Program Notice 01-19; Environmental Management Science Program: Research Related to Deactivation and Decommissioning Issues

Agency: U.S. Department of Energy

Action: Notice inviting grant applications.

SUMMARY: The Offices of Science (SC) and Environmental Management (EM), U.S. Department of Energy (DOE), hereby announce their interest in receiving grant applications for performance of innovative, fundamental research to support specifically innovative, fundamental research to investigate DOE deactivation and decommissioning issues.

DATES: The deadline for receipt of formal applications is 4:30 P.M., E.S.T, March 20, 2001, in order to be accepted for merit review and to permit timely consideration for award in Fiscal Year 2001.

ADDRESSES: Formal applications referencing Program Notice 01-19 should be sent to: U.S. Department of Energy, Office of Science, Grants and Contracts Division, SC-64, 19901 Germantown Road, Germantown, MD 20874-1290, ATTN: Program Notice 01-19. This address must be used when submitting applications by U.S. Postal Service Express, commercial mail delivery service, or when hand carried by the applicant.

FOR FURTHER INFORMATION CONTACT: Dr. Roland F. Hirsch, SC-73, Mail Stop F-237, Medical Sciences Division, Office of Biological and Environmental Research, Office of Science, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874-1290, telephone: (301) 903-9009, fax: (301) 903-0567, E-mail: roland.hirsch@science.doe.gov, or Mr. Mark Gilbertson, EM-52, Office of Basic and Applied Research, Office of Science and Technology, Office of

Environmental Management, 1000 Independence Avenue, SW, Washington, D.C. 20585, telephone: (202) 586-7150, E-mail: mark.gilbertson@em.doe.gov. The full text of Program Notice 01-19 is available via the Internet using the following web site address: http://www.science.doe.gov/production/grants/grants.html.

SUPPLEMENTARY INFORMATION: The Office of Environmental Management, in partnership with the Office of Science, sponsors the Environmental Management Science Program (EMSP) to fulfill DOE's continuing commitment to the clean-up of DOE's environmental legacy.

The DOE Environmental Management program currently has ongoing applied research and engineering efforts under its Technology Development Program. These efforts must be supplemented with basic research to address long-term technical issues crucial to the EM mission. Basic research can also provide EM with near-term fundamental data that may be critical to the advancement of technologies that are under development but not yet at full scale nor implemented. Proposed basic research under this Notice should contribute to environmental management activities that would decrease risk for the public and workers, provide opportunities for major cost reductions, reduce time required to achieve EM's mission goals, and, in general, should address problems that are considered intractable without new knowledge. This program is designed to inspire breakthroughs in areas critical to the EM mission through basic research and will be managed in partnership with SC. The Office of Science's well-established procedures, as set forth in the Office of Science Merit Review System, available on the World Wide Web at: http://www.science.doe.gov/production/grants/merit.html will be used for merit review of applications submitted in response to this Notice. Subsequent to the formal scientific merit review, applications that are judged to be scientifically meritorious will be evaluated by DOE for relevance to the objectives of the Environmental Management Science Program. Additional information can be obtained at: http://www.emsp.em.doe.gov/main.htm. Additional Notices for the Environmental Management Science Program may be issued during Fiscal Year 2001, covering other areas within the scope of the EM program.

Purpose

The purpose of the EMSP is to foster basic research that will contribute to successful completion of DOE's mission to clean-up the environmental contamination across the DOE complex.

The objectives of the Environmental Management Science Program are to:

- Provide scientific knowledge that will revolutionize technologies and clean-up approaches to significantly, reduce future costs, schedules, and risks;
- "Bridge the gap" between broad fundamental research that has wide-ranging applicability such as that performed in DOE's Office of Science and needs-driven applied technology development that is - conducted in EM's Office of Science and Technology; and
- Focus the Nation's science infrastructure on critical DOE environmental management problems.

The focus of the EMSP is on basic research and the objective of this research Program is to develop a long-range science plan for deactivation and decommissioning (D&D). The National Research Council, Committee on Long-Term Research Needs for Deactivation and Decommissioning at Department of Energy Sites, December 5, 2000 report provided technical advise on the "recommended areas of research where the EM Science Program can make significant contributions to solving (D&D) problems and adding to scientific knowledge generally."

Representative Research Areas

Basic research is solicited in all areas of science with the potential for addressing problems in deactivation and decommissioning. Relevant scientific disciplines include, but are not limited to: chemical sciences (including fundamental interfacial chemistry, computational chemistry, actinide chemistry, and analytical chemistry and instrumentation), engineering sciences (including control systems and optimization, diagnostics, transport processes, fracture mechanics and bioengineering), materials science (including other novel materials-related strategies), and bioremediation (including microbial science related to ex situ treatment of organics, metals and radionuclides and in situ treatment of organics).

Project Renewals

Lead Principal Investigators of record for Projects funded under Office of Science Notice 98-04, Environmental Management Science Program: Research Related to Decontamination and Decommissioning of Facilities, are eligible to submit renewal applications under this solicitation.

It is recognized that many of the projects funded in FY1998 of the program have already been very successful. At the same time, we believe that many of these research groups have the potential to make significant additional contributions toward addressing the science needs of the Office of Environmental Management (EM).

Program Funding

It is anticipated that up to a total of $4,000,000 of Fiscal Year 2001 Federal funds will be available for new Environmental Management Science Program awards resulting from this Notice. Multiple-year funding of grant awards is anticipated, contingent upon the availability of appropriated funds. Award sizes are expected to be on the order of $100,000-$300,000 per year for total project costs for a typical three-year grant. Collaborative projects involving several research groups or more than one institution may receive larger awards if merited. The program will be competitive and offered to investigators in universities or other institutions of higher education, other non-profit or for-profit organizations, non-Federal agencies or entities, or unaffiliated individuals. DOE reserves the right to fund in whole or part any or none of the applications received in response to this Notice. A parallel announcement with a similar potential total amount of funds will be issued to DOE Federally Funded Research and Development Centers (FFRDCs) and may be accessed on the World Wide Web at: http://www.science.doe.gov/production/grants/LAB01_19.html. All projects will be evaluated using the same criteria, regardless of the submitting institution.

Collaboration and Training

Applicants to the EMSP are strongly encouraged to collaborate with researchers in other institutions, such as universities, industry, non-profit organizations, federal laboratories and Federally Funded Research and Development Centers (FFRDCs), including the DOE National Laboratories, where appropriate, and to incorporate cost sharing and/or consortia wherever feasible. Refer to: http://www.sc.doe.gov/production/grants/Colab.html for details.

Applicants are also encouraged to provide training opportunities, including student involvement, in applications submitted to the program.

Application Format

Applicants are expected to use the following format in addition to following instructions in the Office of Science Financial Assistance Program Application Guide. Applications must be written in English, with all budgets in U.S. dollars.

- SC Face Page (DOE F 4650.2 (10-91))
- Application classification sheet (a plain sheet of paper with one selection from the list of scientific fields listed in the Application Categories Section)
- Table of Contents
- Project Abstract (no more than one page)
- Budgets for each year and a summary budget page for the entire project period (using DOE F 4620.1)

- Budget Explanation. Applicants are requested to include in the travel budget for each year funds to attend the annual National Environmental Management Science Program Workshop, and also for one or more extended (one week or more) visits to a clean-up site by either the Principal Investigator or a senior staff member or collaborator.
- Budgets and Budget explanation for each collaborative subproject, if any
- Project Narrative (recommended length is no more than 20 pages; multi-investigator collaborative projects may use more pages if necessary up to a total of 40 pages)
- Goals
- Significance of Project to the EM Mission
- Background
- Research Plan
- Preliminary Studies (if applicable)
- Research Design and Methodologies
- Literature Cited
- Collaborative Arrangements (if applicable)
- Biographical Sketches (limit 2 pages per senior investigator)
- Description of Facilities and Resources
- Current and Pending Support for each senior investigator

Application Categories

In order to properly classify each application for evaluation and review, the documents must indicate the applicant's preferred scientific research field, selected from the following list.

Field of Scientific Research:

1. Actinide Chemistry
2. Analytical Chemistry and Instrumentation
3. Bioremediation
4. Engineering Sciences
5. Interfacial Chemistry
6. Materials Science
7. Other

Application Evaluation and Selection

Scientific Merit

The program will support the most scientifically meritorious and relevant work, regardless of the institution. Formal applications will be subjected to scientific merit review (peer review) and will be evaluated against the following evaluation criteria listed in descending order of importance as codified at 10 CFR 605.10(d).

1. Scientific and/or Technical Merit of the Project,
2. Appropriateness of the Proposed Method or Approach,
3. Competency of Applicant's Personnel and Adequacy of Proposed Resources,
4. Reasonableness and Appropriateness of the Proposed Budget.

The evaluation will include program policy factors such as the relevance of the proposed research to the terms of the announcement and the Department's programmatic needs. DOE shall also consider, as part of the evaluation, program policy factors such as an appropriate balance among the program areas, including research already in progress. External peer reviewers are selected with regard to both their scientific expertise and the absence of conflict- of-interest issues. Non-federal reviewers may be used, and submission of an application constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

Relevance to Mission

Researchers are encouraged to demonstrate a linkage between their research projects and significant contamination problems at DOE sites. Researchers could establish this linkage in a variety of ways - for example, by elucidating the scientific problems to be addressed by the proposed research and explaining how the solution of these problems could improve D&D capabilities. Subsequent to the formal scientific merit review, applications which are judged to be scientifically meritorious will be evaluated by DOE for relevance to the objectives of the Environmental Management Science Program.

DOE shall also consider, as part of the evaluation, program policy factors such as an appropriate balance among the program areas, including research already in progress. Research funded in the Environmental Management Science Program in Fiscal Years 1996 through 2000, can be viewed at:
http://emsp.em.doe.gov/portfolio/multisearch.asp.

Application Guide and Forms

Information about the development, submission of applications, eligibility, limitations, evaluation, the selection process, and other policies and procedures may be found in 10 CFR Part 605, and in the Application Guide for the Office of Science Financial Assistance Program. Electronic access to the Guide and required forms is made available via the World Wide Web at:

http://www.science.doe.gov/production/grants/grants.html. DOE is under no obligation to pay for any costs associated with the preparation or submission of applications if an award is not made.

Major Environmental Management Challenges

The safety for workers conducting D&D operations is a issue that will grow as DOE takes on the more challenging D&D tasks. Workers deal with special hazards that are different from those in other parts of DOEs Accelerating Clean-up Paths to Closure (DOE, 1998a), including the following:

- Working in confined spaces in areas of high radioactivity,
- Disassembling and removing massive steel and concrete structures,
- Direct, hands-on manual labor with powerful saws, torches, and lifting devices, and
- Incomplete knowledge of the highly complex systems they are dismantling.

Scientific Issues

The recognized issues pose challenges in characterization, decontamination, and remote systems where current technology is inadequate and where EMSP funded, research could make significant contributions include:

Characterization

Characterization of contaminated materials is critical at several stages of D&D. Initially, the nature and extent of contamination with both radionuclides and toxic materials must be accurately assessed to ensure adequate protection of workers and the environment, as well as to allow the selection of appropriate methods of decontamination. During decontamination and/or demolition of contaminated equipment and structures, there must be some means of monitoring progress and potential contaminant releases. Finally, after decontamination, the nature and extent of residual contamination must be assessed to determine the final classification and disposal of the item in question.

(1) The identification and development of means, preferably real-time, minimally invasive, and field usable, to locate and quantify difficult to measure contaminants significant to D&D. These means should be applicable to the major materials and configurations of interest, such as concrete, stainless steel, and packaged wastes. The contaminants of interest, includes tritium, technetium-99, plutonium-239 and other actinides, beryllium, mercury, asbestos, and polychlorinated biphenyls (PCBs).

Rationale: The varied nature of D&D facilities has led to a wide range of contaminant types and site-specific characterization challenges, each generally requiring a detector tailored specifically to the contaminant being measured and its matrix. Some 2,700 buildings, constructed mostly of concrete and containing 180,000 metric tons of metals, are currently within EM's D&D task. Four areas where research can advance the state of art: (1) methods to assess the distribution of contaminants within concrete; (2) sensors to measure contaminants on the surface and within micro-cracks of metals; (3) remote sensing of contaminants; and (4) biosensors.

The development of minimally- and non-invasive real-time in situ sensing technologies to characterize the concentration of contaminants, as a function of depth within concrete, would eliminate difficulties associated with core sample collection and subsequent analysis. Minimally invasive schemes like laser ablation mass spectroscopy or non-intrusive techniques like neutron activation and x-ray analysis appear to be attractive candidates for further research.

More sensitive detectors, for example for alpha particles (USDOE, 1999), as well as simple-to-use techniques, such as chemical indicators are needed to quickly certify levels of nuclides, hazardous metals, and other toxic substances on structural surfaces and equipment. This will help ensure safety in the workplace and reduce costs—for example by allowing non- hazardous waste to be disposed in landfills. Analysis of residual low-energy beta emitters like tritium and Tc-99 is particularly challenging when these isotopes are inside equipment or mixed in heterogeneous waste matrices, because the beta articles cannot penetrate through most materials.

Remote sensing systems can provide both economic and safety benefits by distancing the worker from hazardous work areas. Remote mapping of activity levels using gamma cameras (USDOE, 1998b) is now being used to great advantage in D&D operations. Smaller, higher sensitivity and resolution versions of these instruments would be desirable and may be achievable through further research on detector materials and geometries. Fiber-optic sensing for remote detection of some chemical species is feasible. Further research could lead to its use in sensing chemical contaminants relevant to D&D. Fiber-optic radiation sensors are a more recent development and opportunities exist for both improved performance and novel features such as optical interrogation.

(2) The basic research that could lead to development of biotechnological sensors to detect contaminants of interest may provide a completely new way to meet the needs for characterization of contaminated materials. The field of biotechnology is rapidly expanding, and the contaminants of interest and the materials and configurations in which they must be detected, is noted in (1).

Rationale: There has been tremendous growth in development and commercialization of a broad range of biosensor devices and applications. Modern devices can range from fiber-optic and micro-cantilever-linked immuno assays to subcellular and cellular micro-electronic. Analytes measurable by biosensors include a vast array of organic chemicals, biochemicals, inorganics, and metals and more recently ionizing radiation. Research to integrate microelectronics and nanotechnology with elements of gene array technology and cellular engineering may lead to new sensor technology (see http://www.nano.gov/press.htm for details). This technology could create new capacity for continuous and remote monitoring in chemically and physically complex environmental and structural systems characteristic of DOE's site D&D needs.

Decontamination

The decontamination of equipment and facilities is necessary at several stages of the D&D process. Initially, radiation and contamination levels may have to be reduced to allow worker access or to limit their exposure to radiation and other hazards. Decontamination may be required before dismantling or demolition work to prevent the spread of radioactive or toxic materials. Unplanned releases can have off-site as well as on-site consequences. Decontamination procedures are intended to result in a small volume of the most hazardous waste, and much larger volumes of waste that has low or no hazard, thus reducing the cost and long-term risk of disposal. Some decontaminated equipment or facilities might be recycled or reused. The end state of any decontamination activity must be consistent with both site-specific and overall DOE clean-up objectives.

(3) The basic research toward fundamental understanding of the interactions of important contaminants with the primary materials of interest in D&D projects, including concrete, stainless steel, paints, and "strippable" coatings is needed.

Rationale: Scientific understanding of the interactions among contaminants and construction materials is fundamental to developing more effective D&D technologies. Both radioactive and toxic contaminants can exist in a variety of chemical forms (for example, in different valence states, complexes, or as colloids), which exhibit very different behaviors. While a good deal of chemical data on the contaminants themselves exist as well as data on their transport in the environment there is little information of direct relevance to D&D problems. Such information includes how contaminants bind to steel and concrete surfaces, how they penetrate into these materials, their migration into pores, fissures, and welds, and time-dependent "aging" effects. Once sufficient thermodynamic and kinetic data on these interactions are obtained to allow their modeling from first principles, the models would allow various decontamination approaches to be evaluated and provide a better way to interpret data from characterization.

(4) The basic research on biotechnological means to remove or remediate contaminants of interest from surfaces and within porous materials.

Rationale: The capacity of microbiological processes to destroy, transform, mobilize, and sequester toxins, pollutants, and contaminants is well-established. Through research to extend well-known technology in mineral ore leaching and metal recovery, these biochemical capacities may be exploitable for removal of metals and radionuclides from concrete and building debris. An excellent example of which was recently described in an American Society for Microbiology report (see ASM News. 66:133). In addition, microbial biocorrosion processes for structural metals and concrete are well established and the opportunity exists to investigate fundamental processes that could facilitate volumetric reduction of waste from D&D activities. Biotechnical advances in surface treatments of contaminated structures and materials are anticipated from continuing R&D activities, elucidation of biocatalytic properties of biological systems and engineering chemicals, and biosurfactants with unique physical chemical properties. A fundamental understanding of the biological processes would also help to ensure that waste by-products from the decontamination could be safely treated and stabilized.

Remote Systems

For D&D work, remote systems provide a unique means to separate workers from hazardous work areas, thus enhancing their safety and productivity. This technology crosscuts all of the other D&D areas—characterization, decontamination, and dismantlement—and has the potential for substantial performance enhancement and cost reduction. There are broad ranges for potential applicability of fundamental advances in this area.

(5) The basic research toward creating intelligent remote systems that can adapt to a variety of tasks and be readily assembled from standardized modules. Today's remote systems are one-of-a-kind devices of high cost and limited capability. Their inflexibility leads to rapid obsolescence and is a barrier to their deployment. The recommended initial research focus would be as follows:

a. Actuators

Rationale: The actuator is the power (muscle) of remote systems, and as such, it is the key to performance, reliability, and cost. Except for better construction materials and improved control electronics, most actuator technology has not changed for several decades. Today's actuators typically use only one sensor (for position) so that virtually no real time data (for example, force and velocity) are available to make them "intelligent." More complete sensory input, coupled with decision-making software can produce intelligent actuators that are able to adapt to a variety of tasks.

Achieving a relatively inexpensive modular design to allow "plug and play" deployment of these devices would be especially useful because equipment that fails or becomes contaminated is usually discarded. Research to answer the question of granularity (What is the minimum number of required standard modules?) to enable the assembly on demand of the maximum number of remote systems would make the overall system substantially more cost effective in deployment and maintenance.

b. Universal Operational Software to Provide Criteria-Based Decision Making
Rationale: Criteria-based decision making is the essence of intelligence in robotic systems. What is the best use of the system's resources to perform the task at hand? Today's control of robotic devices is derived from techniques developed during World War II in which control is linear (based only on the difference between two measured parameters). A robot capable of mimicking human adaptability, however, would require a non-linear control system coupled to many parameters corresponding to the physical features that accurately represent performance of the task. The criteria-based software could be universal in the same sense that operating systems on personal computers are universal—one system supports many different applications.

c. Virtual Presence of the Worker in Hazardous Environments
Rationale: In the initial planning and characterization phases of D&D work, workers often must enter an area of high radiation and contamination that is also congested with left-in- place equipment and materials for which removal inevitably involves physical stress (fatigue) and the potential for personal injury. Virtual reality systems could allow workers to perform essential survey and decision making functions from a remote location thus enhancing their safety and productivity. Advances in the state of the art as now used in deep sea exploration should be pursued to improve overall system performance by providing force feedback, remote vision, collision avoidance, and radiation resistant sensor technology.

The nature and extent of contamination with both radionuclides and toxic materials must be accurately assessed to ensure adequate protection of workers and the environment, as well as to allow the selection of appropriate methods of decontamination.

Background

DOE expects to spend some $30 billion for D&D of weapons complex facilities after 2006. For example the Savannah River and Hanford sites present the biggest D&D challenges and will be undertaken after 2006 with about half of the $30 billion being saved through use of innovative technologies that it expects could be developed by that time.

The United States involvement in nuclear weapons development for the last 50 years has resulted in the development of a vast research, production, and testing network

known as the nuclear weapons complex. The Department has the challenge of deactivating 7,000 contaminated buildings and decommissioning 900 contaminated buildings that are currently on DOE's list of surplus facilities. It is also responsible for decontaminating the metal and concrete within those buildings and disposing of 180,000 metric tons of scrap metal. Deactivation refers to ceasing facility operations and placing the facility in a safe and stable condition to prevent unacceptable exposure of people or the environment to radioactive or other hazardous materials until the facility can be decommissioned. Typically, deactivation involves removal of fuel and stored radioactive and other hazardous materials and draining of systems. Decommissioning is the process of decontaminating or removing contaminated equipment and structures to achieve the desired end state for the facility. Desired end states include complete removal and remediation of the facility, release of facility for unrestricted use, or release of facility for restricted use. Decontamination is the removal of unwanted radioactive or hazardous contamination by a chemical or mechanical process.

Details of the programs of the Office of Environmental Management and the technologies currently under development or in use by Environmental Management Program can be found on the World Wide Web at: http://www.em.doe.gov/index4.html and at the extensive links contained therein. The programs and technologies should be used to obtain a better understanding of the missions and challenges in environmental management in DOE when considering areas of research to be proposed.

References

Note: World Wide Web locations of these documents are provided where possible. For those without access to the World Wide Web, hard copies of these references may be obtained by writing Mark A. Gilbertson at the address listed in the FOR FURTHER INFORMATION CONTACT section.

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The Catalog of Federal Domestic Assistance Number for this program is 81.049, and the solicitation control number is ERFAP 10 CFR Part 605.

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for Resource Management

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