Office of Science
Notice 03-12

Environmental Management Science Program (EMSP): Research Related to Transuranic and Mixed Wastes

Department of Energy

Office of Science Financial Assistance Program Notice 03-12; Environmental Management Science Program (EMSP): Research Related to Transuranic and Mixed Wastes

AGENCY: U.S. Department of Energy

ACTION: Notice inviting grant applications.

SUMMARY: The Office of Biological and Environmental Research (OBER) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announce its interest in receiving grant applications to support the performance of innovative, fundamental research on the characterization of transuranic (TRU) and mixed wastes (MW) that are currently stored at DOE sites, or will be produced as part of DOE's environmental cleanup efforts.

DATES: The deadline for receipt of formal applications is 4:30 P.M., E.S.T., Tuesday, March 4, 2003, in order to be accepted for merit review and to permit timely consideration for award in Fiscal Year 2003.

ADDRESSES: Formal applications in response to this solicitation are to be electronically submitted by an authorized institutional business official through DOE's Industry Interactive Procurement System (IIPS) at: http://e-center.doe.gov. IIPS provides for the posting of solicitations and receipt of applications in a paperless environment via the Internet. In order to submit applications through IIPS your business official will need to register at the IIPS website. The Office of Science will include attachments as part of this notice that provide the appropriate forms in PDF fillable format that are to be submitted through IIPS. Color images should be submitted in IIPS as a separate file in PDF format and identified as such. These images should be kept to a minimum due to the limitations of reproducing them. They should be numbered and referred to in the body of the technical scientific application as Color image 1, Color image 2, etc. Questions regarding the operation of IIPS may be E-mailed to the IIPS Help Desk at: HelpDesk@pr.doe.gov or you may call the help desk at: (800) 683-0751. Further information on the use of IIPS by the Office of Science is available at: http://www.science.doe.gov/production/grants/grants.html.

If you are unable to submit an application through IIPS please contact the Grants and Contracts Division, Office of Science at: (301) 903-5212 in order to gain assistance for submission through IIPS or to receive special approval and instructions on how to submit printed applications.

FOR FURTHER INFORMATION CONTACT:

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Office of Biological and Environmental Research
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Or

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Office of Environmental Management, EM-50
1000 Independence Avenue, SW
Washington, D.C. 20585
telephone: (202) 586-7150
facsimile: (202) 596-1492
E-mail: mark.gilbertson@em.doe.gov

The full text of Program Notice 03-12 is available on the World Wide Web at: http://www.science.doe.gov/production/grants/grants.html.

SUPPLEMENTARY INFORMATION:

The Environmental Management Science Program: Over the past 60 years, the United States created an industrial complex to develop, test, manufacture, and maintain nuclear weapons for national security purposes. The production and testing of nuclear weapons created a legacy of significant environmental contamination, ranging from uranium mining and milling, waste disposal, and radionuclide migration in ground water and soil. In 1995, the 104th Congress authorized creation of the Environmental Management Science Program (EMSP) to develop a long term, basic science infrastructure that would focus on scientific and technical challenges facing DOE's environmental cleanup effort. Since its inception in 1996, the Program has held seven competitions and has awarded over $320 million in funding to nearly 400 research projects. To address the largest environmental cleanup program in the world, from a cost perspective, EMSP has the following objectives:

- to provide scientific knowledge that will revolutionize technologies and cleanup approaches to significantly reduce future costs, schedules, and risks;
- to "bridge the gap" between broad fundamental research that has wide-ranging applicability and needs-driven applied technology development;
- to focus the Nation's science infrastructure on critical DOE environmental management problems.

Basic research proposed under this Notice should contribute to DOE's environmental management activities by decreasing risk for the public and workers, providing opportunities for major cost reductions, reducing the time required to achieve DOE's mission goals, and, in general, should address problems that are considered intractable without new knowledge.

TRU and Mixed Waste Challenge: DOE's inventory of transuranic and mixed wastes (TM wastes) includes about 155,000 cubic meters of waste stored on some 30 DOE sites and another 450,000 cubic meters of buried waste-at least some of which is likely to require retrieval in the course of DOE's site cleanup program. Most of the stored inventory is in 55-gallon drums or other containers. Although some of the buried waste is similarly packaged, knowledge of the condition of the containers and their contents is limited.

Information on DOE's waste inventory has been summarized in a recent report (USDOE, 2001), and is also available via the World Wide Web at DOE's Central Internet Database (http://cid.em.doe.gov). A short summary of the nature of DOE's TM wastes, including definitions of TRU and MW, is given in the "Background Information" section of this Notice.

While DOE is making a concerted effort to accelerate the removal of TM wastes from its sites, the size of the inventory translates to a multi-decade effort that will require handling, characterizing, shipping, and disposing of hundreds of thousands of waste drums and other containers at a total cost of billions of dollars.

Overall, it is the intent of this Notice to solicit and encourage research that will provide the scientific basis for the new technologies and approaches that will be necessary to characterize DOE's MW and TRU wastes over the next decades, and to enhance the quantity and quality of scientific information available for decision-making.

Research Needs: This research Notice has been developed for Fiscal Year 2003, with the primary objective of developing scientific knowledge that will enable major advances in technologies available for characterizing TRU and MW waste. This section provides a summary of research needs in this area, and is based on a National Academy of Sciences, National Research Council (NRC) report published in 2002 entitled "Research Opportunities for Managing the Department of Energy's Transuranic and Mixed Wastes (National Research Council, 2002"). That report identified significant knowledge gaps and research opportunities in a number of areas; however, due to the limited funds expected to be available to support new EMSP projects in Fiscal Year 2003, this Notice focuses on research needs for waste characterization, including characterization and detection of buried wastes.

Research is needed to improve the efficiency of characterizing DOE's TRU and mixed waste inventory. This includes research toward developing faster and more sensitive characterization and analysis tools to reduce costs and accelerate throughput, particularly for waste that produces sufficient penetrating radiation that it requires remote handling. It also includes research to develop a fuller understanding of how waste characteristics may change with time (chemical, biological, radiological, and physical processes) to aid in decision making about disposition paths and to simplify the demonstration of regulatory compliance.

Determining the physical, chemical, and radiological properties of TM wastes pertinent to handling, processing, transportation, and storage is costly and time-consuming. The problem is amplified by the wide variety of the wastes and their heterogeneity. Improving and simplifying waste characterization can reduce costs and increase the rate of shipping wastes to disposal facilities.

There is a need for faster and more sensitive characterization technologies, for making automated sampling more reliable, and for improving statistical sampling methods. There is a lack in basic knowledge of how waste characteristics may change with time, including both short-term changes that affect storage and shipment and long-term changes that may occur in a disposal facility. This lack of knowledge drives conservatism in characterization, transportation, and disposal requirements. Possible microbial effects in waste have generally been ignored.

The greatest challenges for the next generation of characterization technologies will be to provide the following:

- more rapid, automated nondestructive assay and evaluation methods;
- more sensitive nondestructive assay and evaluation technologies for larger containers and hard-to-detect contaminants; and
- improved methods, based on fundamental modeling, to derive present and future waste characteristics from a limited number of sampling parameters.

Research toward new, noninvasive, remote imaging and image recognition methods and in-drum sensors to provide faster and more sensitive technologies for characterization could lead to significant savings in time, cost, and risk of worker exposure. Although noninvasive diagnostics are highly preferred, the use of minimally invasive sensors also has promise.

Research is needed to evaluate the microbiology of MW and TRU wastes. This research should focus on identifying the microorganisms that exist in the waste, and evaluating their relationship to waste materials (i.e., whether these microbes affect the hazardous or radioactive components of the waste in ways that make it more or less toxic, or more or less suitable for disposal in hazardous waste, low-level waste, or other landfills or repositories. Additional research is needed to develop tools for rapidly diagnosing microbial activity or identifying specific microbes.

One of the most beneficial cost-saving tools would be the formulation of more reliable predictive models, validated by experimental data, of how waste characteristics may change with time due to chemical, biological, radiological, and physical processes. This would be most useful in

predicting deleterious processes that might occur in the waste, such as gas generation or matrix degradation.

PROGRAM FUNDING: It is anticipated that up to a total of $2,000,000 of Fiscal Year 2003 funds will be available for new EMSP 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 Notice with a similar potential total amount of funds will be issued to DOE Federally Funded Research and Development Centers (FFRDCs). All projects will be evaluated using the same criteria, regardless of the submitting institution.

COLLABORATION AND TRAINING: Applicants to the EMSP are encouraged to collaborate with researchers in other institutions, such as universities, industry, non-profit organizations, federal laboratories and FFRDCs, including the DOE National Laboratories, where appropriate. Applicants are also encouraged to provide training opportunities, including student involvement, in applications submitted to EMSP.

APPLICATION FORMAT: Applicants are expected to use the following format in addition to following instructions in the Office of Science Application Guide (see: http://www.science.doe.gov/production/grants/guide.html). Applications must be written in English, with all budgets in U.S. dollars. In the case of applications involving multiple institutions, only one application that encompasses the entire scope of the proposed research should be submitted; however, the application should include separate budgets and budget explanations for each participating institution.

- Office of Science 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. (Note: applicants are requested to include in the travel budget funds to attend: (1) an initial research kick-off meeting; (2) an annual EMSP workshop; and (3) one or more extended visits (1 to 2 weeks in duration) to a cleanup site by the Principal Investigator, a senior staff member, or a collaborator
- Budgets and Budget explanations for each collaborating institution, 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 35 pages)
    - Project Goals
    - Significance of Project to the EM Mission

    - Background
    - Preliminary Studies (if applicable) and/or Summary of Results from Previous Research (if application is a renewal)
    - Research Plan
    - Research Design and Methodologies
- Literature Cited
- Collaborative Arrangements (if applicable)
- Biographical Sketches of Senior Investigators (limit 2 pages per 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. Engineering Sciences
4. Geochemistry
5. Geophysics
6. Inorganic Chemistry
7. Materials Science
8. Biology (including Microbiology)
9. Other

APPLICATION EVALUATION AND SELECTION:

Scientific Merit: Applications will be subjected to scientific merit review (peer review) and will be evaluated against the following criteria listed in descending order of importance as codified at 10 CFR Part 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.

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(s).

Relevance to Mission: In addition 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 EMSP. DOE will also consider, as part of the evaluation, program policy factors such as an appropriate balance among the program areas, including research already in progress. Additional

information about the general program can be found at: http://emsp.em.doe.gov. Past research solicitations, abstracts, and research reports of projects funded under EMSP can be found at: http://emsp.em.doe.gov/researcher.htm.

Applicants are encouraged to demonstrate a linkage between their research projects and significant problems related to MW and TRU waste at DOE sites. This linkage can be established 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 lead to improved capabilities that would reduce costs, accelerate throughput, or reduce the risk of worker exposure. It is understood that given the nature of basic research, there will not always be a clear pathway between research results and application to site remediation.

A listing of points of contact and site web pages is provided for applicants who may have site-specific questions related to TRU and MW problems:

Hanford (http://www.hanford.gov): Rudy Garcia, (509) 376-5494, Rudolph_F_Garcia@rl.gov.

Idaho (http://www.id.doe.gov): William Owca, (208) 526-1983, owcawa@id.doe.gov.

Oak Ridge (http://www.oro.doe.gov): for TRU - Gary Riner, (805) 241-3498, rinerg@oro.doe.gov; for MW - Brian Westich, (805) 241-2198, westichb@oro.doe.gov.

Savannah River (http://sro.srs.gov): for TRU - Bert Crapse, (803) 725-9866, Herbert.Crapse@srs.gov or Ann Gibbs, (803) 952-2265, Ann.Gibbs@srs.gov; for MW - Mike Simmons, (803) 725-1627, Jonathan.Simmons@srs.gov or Bernie Mayancsik, (803) 952-2271, Bernadette.Mayancsik@srs.gov.

Waste Isolation Pilot Plant (http://www.wipp.carlsbad.nm.us): George Basabilvazo, (505) 234-7488, George.Basabilvazo@wipp.ws

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 available on 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 made.

BACKGROUND INFORMATION: Information on DOE's waste inventory has been summarized in a recent report (USDOE, 2001), and is also available via the World Wide Web at DOE's Central Internet Database (http://cid.em.doe.gov). The two categories of waste listed in these sources that are pertinent to this Notice are transuranic (TRU) and mixed low-level waste (MLLW). Transuranic waste is defined by DOE Order 435.1 as waste that contains more than 100 nanocuries *per* gram arising from alpha-emitting radionuclides having atomic numbers greater than that of uranium (92) and half-lives greater than 20 years. Low-level waste (LLW) is

defined in the Low-Level Radioactive Policy Amendments Act of 1985 by what it is **not**, and consequently is a very broad category of waste. LLW is defined as waste that is not spent nuclear fuel, not high-level waste resulting from reprocessing of spent nuclear fuel, and not byproduct material as defined in section 11e.2 of the Atomic Energy Act of 1954. LLW encompasses materials that are slightly above natural radiation background levels to highly radioactive materials that require extreme caution when handling. Hazardous waste is defined by the U.S. Environmental Protection Agency (EPA) in Title 40 of the Code of Federal Regulations, Parts 260 and 261, as a subset of solid wastes that pose substantial or potential threats to public health or the environment and that meet any of the following three criteria: (1) waste that is specifically listed as a hazardous waste by EPA; (2) waste that exhibits one or more of the characteristics of hazardous waste (ignitability, corrosiveness, reactivity, and/or toxicity); or (3) waste that is generated by the treatment of hazardous waste, or is contained in a hazardous waste. Mixed low-level waste (MLLW) is waste that meets the above definitions of both LLW and hazardous waste. It contains low levels of radioactive contamination as well as materials that are chemically hazardous. Mixed transuranic waste (MTRU) is waste that meets the definitions of both TRU and hazardous wastes. The EPA estimates that over half of DOE's TRU inventory is MTRU (EPA 2002); however, because all of DOE's retrievably stored, defense TRU wastes are slated for disposal in the Waste Isolation Pilot Plant (WIPP), DOE no longer distinguishes MTRU as a special category in its inventory (USDOE, 2001).

Since 1970, DOE sites have stored most TRU waste and MW in retrievable 55-gallon drums or larger containers for future treatment (if needed) and disposal. Prior to 1970, DOE sites buried materials that meet the current definition of TRU waste and MW in shallow land facilities, within about 30 meters of the surface. A much smaller fraction of these wastes were buried at depths between 30 and 300 meters. Most of this waste was buried in 55-gallon drums; however, some was buried in other types of containers, and some had no form of durable containment. At the time, DOE considered buried wastes to be permanently disposed, but some of the buried wastes may require retrieval and treatment.

The previous practice of discharging low-level liquid wastes to retention basins has resulted in the generation of contaminated soils and sediments. DOE recognizes that some of these materials are sufficiently contaminated to warrant retrieval. Such materials are termed "*ex-situ* contaminated media" in the inventory summary (USDOE 2001). If they are retrieved, both the pre-1970 buried wastes and the *ex-situ* media will be considered newly generated waste. In addition to these historical wastes, activities at DOE sites, including environmental cleanup activities, will continue to generate new MLLW and TRU wastes over the next several decades.

The materials making up DOE's inventory of MW and TRU wastes are extremely diverse. This diversity was described in a report (USDOE, 1995) based on data compiled by the various DOE sites in order to develop site remediation plans. The inventory was divided into five groups, each with various subcategories:

1. Debris

    - metallic debris (including materials containing lead and cadmium)
    - inorganic, nonmetallic debris (e.g., concrete, glass, graphite, and rock)

- organic debris (e.g., such as rubber, leaded gloves, halogenated and nonhalogenated plastics, wood, paper, and biological materials
- heterogeneous debris (e.g., composite fillers, asphalt, electronic equipment, and other types of organic and inorganic materials)

2. Inorganic homogenous solids and soils

- homogeneous solids (e.g., ash, sandblasting media, inorganic particulate absorbents, absorbed organic liquids, inorganic ion-exchange media, metal chips and turnings, glass, ceramics, and activated carbon)
- sludges (e.g., sludges arising from wastewater treatment ponds, off-gas treatment, plating activities, and low-level reprocessing)
- other wastes (e.g., paint chips, solids, and sludges, salt waste containing chlorides, sulphates, nitrates, metal oxides/hydroxides, and other inorganic chemicals)
- solidified homogeneous solids (e.g., soil and gravel)

3. Organics

- liquids (aqueous streams containing both halogenated and nonhalogenated organic compounds)
- homogeneous solids (e.g., particulate matter such as resins and absorbents, biological sludges, halogenated and nonhalogenated organic sludges, and organic chemicals)

4. Unique wastes

- Lab packs (e.g., organic, aqueous, and solid laboratory chemicals and scintillation cocktails)
- Special wastes (e.g., elemental mercury, lead, and cadmium, beryllium dust, batteries, reactive metals in bulk and as contamination in/on other components, pyrophoric particulates, explosives or propellants, and compressed gasses and aerosols)
- All others (materials placed in a final waste form are included in this category)

5. Wastewaters

- Aqueous liquids and slurries ranging from acidic to basic pH, including cyanide-containing materials.

The 1995 inventory also characterized DOE's level of confidence as to how well the wastes were characterized. In general terms, DOE has high or medium confidence that the physical nature (i.e., soil or sludge) of most wastes is correctly identified, but it lacks confidence in the existing quantitative data on the wastes' chemical and radioactive constituents.

The volume and diversity of DOE's MW and TRU wastes pose significant challenges for disposing of this waste. Currently, DOE's TRU waste disposal efforts are focused on maximizing

the utility of the WIPP. Several hundred thousand drums of TRU waste will need to be shipped to WIPP, and the characterization required for shipping and acceptance at the WIPP currently requires many hours and costs thousands of dollars for each drum of waste generated prior to 1999. Methods to improve characterization are therefore likely to result in significant savings of time and money.

Some components in TRU waste are problematic for shipping to or disposal in the WIPP. About two percent (approximately 14,200 drum equivalents) of DOE's TRU waste contains organic materials that continue to pose shipping problems due to potential gas generation, especially of hydrogen. Drums containing reactive and corrosive chemicals, as well as drums containing liquids, sealed containers, and gas cylinders (including paint cans) may not be accepted by the WIPP, and they are currently removed by manually sorting through the waste. Waste that is contaminated with polychlorinated biphenyls (PCBs) constitutes about one percent of the inventory, and currently cannot be accepted by the WIPP. Approximately two to four percent of the TRU waste inventory produces sufficient penetrating radiation from fission products that it requires remote handling, rather than hands-on operator contact. The requirement for remote handling greatly increases the cost and difficulty of characterizing, treating, and packaging or repackaging of this waste. Meeting the per-drum limits on heat generation and fissile material content can necessitate repackaging of the waste. In addition to increasing the waste volume, repackaging to meet these limits is expensive, time-consuming, and creates the potential for worker exposure.

DOE currently relies primarily on private contractors and commercial facilities for treating and disposing of its MLLW. (MLLW cannot be disposed in the WIPP because under current law, only TRU waste can be disposed there). The characterization and treatment of MLLW that will be necessary to meet the disposal requirements of the Resource Conservation and Recovery Act (RCRA) have received relatively little attention compared to TRU waste. Despite the general lack of quantitative chemical characterization, it is known that much of DOE's MLLW inventory contains hazardous chemicals that can be difficult to treat (e.g., heavy metals, solvents and other organics, and mercury). Furthermore, there is considerable commingling of these materials, which complicates the selection of disposition options. MLLW that contains certain specified materials is prohibited from near-surface disposal under current EPA and Nuclear Regulatory Commission (NRC) regulations. These include the following:

- liquids,
- reactive or explosive materials,
- flammable materials,
- untreated biological material,
- materials that may emit toxic gases or fumes,
- other materials subject to the EPA's land disposal restrictions, as listed in 40 CFR 268,
- radioactive isotopes that exceed the NRC limits for Class C wastes (>700 Ci/m3 of 63Ni, or >7,000 Ci/ m3 of 90Sr, or >4,600Ci/ m3 of 137Cs).

In order to be disposed, these wastes will require treatment that may be difficult and expensive. Characterization of the wastes is a necessary first step in the selection of disposition options.

REFERENCES:

National Research Council, 2002, *Research Opportunities for Managing the Department of Energy's Transuranic and Mixed Wastes*. National Academy Press, Washington, D.C., 118pp. http://www.nap.edu/books/0309084717/html/

USEPA, 2002, *Mixed Waste Glossary*. EPA Radiation Protection Program Waste Management Team. Available at: http://www.epa.gov/radiation/mixed-waste/mw_pg5.htm

USDOE, 1995, *The DOE National 1995 Mixed Waste Inventory Report*. U.S. Department of Energy, Washington D.C.

USDOE, 2001, *Summary Data on the Radioactive Waste, Spent Nuclear Fuel, and Contaminated Media Managed by the U.S. Department of Energy*. April 2001, U.S. Department of Energy, Washington D.C. http://cid.em.doe.gov/

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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