The "Wolf-Broido" Initiative

OTD SENIOR STAFF MEETING - JUNE 5

FY 1996 COLLABORATION BETWEEN EM-OTD AND DOE-ER

- by STAN WOLF

SCOPE:

- FUNDING: - $2-3 MILLION FROM DOE-ER IN FY1996
  - NO FUNDS COMMITTED FROM EM-OTD

- TYPE AND DURATION OF PROJECTS: BASIC RESEARCH FOR 2-3 YEARS

- HQ PARTICIPANTS: POINTS OF CONTACT (M. BROIDO, S. WOLF) AND EM-OTD AND ER PROGRAM MANAGERS

- RESEARCH TO BE DONE BY DOE-ER CONTRACTORS (DOE LABS; MAY BE COLLABORATIVE WITH EM-OTD OR OTHER GROUPS)

THREE-PHASE APPROACH:

- PHASE I - ER FUNDED BASIC RESEARCH; $2-3 MILLION IN FY1996 FROM ER=OHER AND ER-OBES

  - PROBLEM DEFINITION - BY OTD PROGRAM MANAGERS INITIALLY, REFINED JOINTLY BY OTD/OHER/OBES

    - OTD CROSSCUT PROGRAM-INVOLVEMENT

    - 2-3 YEAR BASIC RESEARCH PERIOD

  - CONCEPT PROPOSALS AND FULL PROPOSALS – FROM ER LABS

  - INTERNAL AND EXTERNAL ER/EM PROPOSAL REVIEW

  - ER MANAGEMENT OF PROJECTS, WITH EM INPUT

EM-OTD/DOE-ER COLLABORATION - continued

- PHASE II (IF NEEDED) - JOINT ER/EM-OTD FUNDING OF TRANSITION FROM BASIC TO APPLIED RESEARCH

- PHASE III (MAY BE CONCURRENT WITH PHASE I) - EM-OTD FUNDING OF TECHNOLOGY DEMOS AND USE OF ER RESULTS

<u>ACTIONS TAKEN TO DATE:</u>

- COORDINATION ESTABLISHED: M. BROIDO, ER; S. WOLF, EM

- APPROACH DEVELOPED - SEE ABOVE

- SCHEDULE SET

    - JUNE, 1995: FORMAL MEMO FROM DASs (FROM EM-OTD AND ER-OHER and ER OBES) TO AS-EM AND AS-ER

      FINAL MEMO OUTLINING CONCEPT AND PROCESS IS BEING PREPARED THIS WEEK (BY M. BROIDO, ER)

    - JUNE - NOVEMBER - SOLICIT, RECEIVE, AND REVIEW PROPOSALS; SELECT AND FUND PROJECTS

    - JANUARY, 1996 - SELECTED PROJECTS START

- CONTACT MADE WITH OTD CROSSCUT PROGRAM MANAGERS

    - SCOPE AND APPROACH OUTLINED

    - PROGRAM DRAFT PROBLEM STATEMENTS RECEIVED, EG.,

        - TRITIATED WATER TRANSPORT IN POLYMER MEMBRANES

        - SENSORS FOR CONE PENETROMETER

INFORMATION TO BE INCLUDED IN EM PROBLEM STATEMENTS FOR DOE-ER

- TO BE PROVIDED BY EM-50 CROSSCUT PROGRAM MANAGERS

- FOR FY1996 ER/EM COLLABORATION ($2-3 MILLION OF ER FUNDS)

1. Each problem description should provide sufficient details of the EM-50 needs, on-going activity, and plans to assist DOE-ER contractors to propose basic research supporting the applied programs and being able to be brought to fruition in 2-3 years:

- description - 1 paragraph stating

    - EM problem being addressed by EM-50 work

    - goals (time frame, size scale, engineering parameters) and work scope of EM-50 effort

    - PI location, phone number

    - salient results

    - why basic research needed,

    - suggested directions for basic research, e.g., for the first Separations topic (attached), an appropriate direction might be evaluation of selected classes polymers, their engineering parameters, physical properties, selectivity might be appropriate

    NOTE: Each EM-50 crosscut program is encouraged to provide one problem principally focused on an EM-30 problem, another on EM-40, and another on EM-60.

2. Information based on proposals previously submitted to EM-50 crosscut programs in the past which were too basic for us to fund, which might help our programs, and which might be of interest for ER to support

- principal investigator(s) of the proposals

- information on proposer -title, location, and phone number

- topical area of proposal

- ER program or program manager anticipated to handle the proposal

NOTE: We may wish to transfer to ER any proposals which fall in this category of being too basic for us to support.

July l9

SUBJECT: CHARACTERIZATION MONITORING AND SENSOR TECHNOLOGY AREAS FOR ER/EM COLLABORATION IN FY1996

Description of EM-30 Need: Sensors for In Situ Determination of Chemical and Stratigraphic Properties of High-Level Storage Tank

The U S. DOE has generated millions of gallons of high-level radioactive waste most of which are now stored in underground storage tanks. Over the years, waste management practices focused on maximizing tank storage capacity while minimizing new tank construction by such means as reducing the volume of high activity liquids by precipitating out the 137Cs and 90Sr with the addition of ferrocyanide, evaporating and pumping off the liquid, and sometimes commingling wastes from different processes by pumping liquid from one tank to another. These practices produced a complex, multi-phase, and highly stratified mixture of saltcake (with or without interstitial liquids), sludge, and supernatant. The consistency of these layers ranges from peanut butter to rock, and varies from tank to tank. The complexity of waste mixtures with associated aging degradation and thermal/radiolysis reactions poses such safety concerns as reactivity, flammability, high heat, criticality, and hazardous gas emission. In general, the tank wastes are composed of nitrate and nitrite salts (approximately half of the total waste), as well as hydrated metal oxides, phosphate precipitates, transuranics, and isotopes of strontium (9OSr), iodine (129I), cesium (137Cs), and technetium (99Tc). The environment within the tanks is highly caustic (pH>12) with a temperature from ambient to over 93-83 C.

Long Term Goal: In situ techniques that can be deployed (e.g., by a cone penetrometer, a core drilling truck, or other devices that provide adequate penetration thrust through the saltcake) are needed to characterize the homogeneity in various waste matrices (liquids, saltcake, and sludge) within the tanks. Specifically, the following characteristics are targeted: water content (weight percent); total organic carbon content (weight percent); fissile material content (ug/g); heat generation (9OSr and 137Cs) (Btu/hr/lb.); and stratigraphic layers (consistency or waste anomalies including detection of buried objects).

Basic Research Support Needed: Techniques for measuring properties and characteristics of water organics fissi1e materials and fission products in a complex environment. These techniques must be able to interrogate a large waste volume to assure that the representative and selective sampling analysis will be obtained. Devices and systems for in situ deployment must be capable of performing in a radiation field of 5,000 rad/hr for a period of up to 10 hours.

Related Tasks:

Task Name	PI Name/Affiliation	Phone Number
Cone Penetrometer for In Situ Waste Tank Characterization (TWRS)	Nick Boechler, WHC	(509) 373-3041

Acoustic Characterization - Wastes in USTs	David Martin, Ames (515) 294-3344
Evaluate Feasibility of Acoustic Imaging in Tank Wastes (TWRS)	Steve Mech, WHC (509) 376-8858
Electromagnetic Moisture Measurement	Ronald Hockey, PNL (509) 375-2813
Fiber Optic Near Infrared Spectrometer System	Ron Eschenbaum,WHC (509) 376-7439
Imaging Through Obscurants	D. McMakin, PNL (509) 375-2206
Interactive Computer-Enhanced Remote Viewing System (METC)	John Wagner, Mechanic Tech. (518) 785-2800
Laser Range Finder and Structured Light Mapping System	Ron Eschenbaum, WHC (509) 376-7439

Description of EM-40: Need Characterization of Flow and Contaminant Transport in Fractured Rock

Improved characterization of preferential flow and contaminant transport in fractured rock is needed to support risk and performance assessment and remediation action decision-making at several DOE sites In two important cases contamination is already present in the saturated zone (for example from deep injection of contaminants into fractured shales at ORNL and from injection well disposal of waste into fractured basalt at INEL) Also at INEL and ORNL large quantities of waste are buried or stored above aquifers in fractured rock and groundwater contamination caused by infiltration has already occurred or there is significant potential that it will occur.

Contamination in fractured rock is problematic and basic research is required to identify measure and understand the key physical geologic and hydrologic factors that control the flow transport and hold-up of contaminants. In addition, applied research is required to provide, demonstrate and evaluate tools/methods for measuring those factors and the flow transport and contaminant hold-up. This information is required to establish conceptual models which are essential to help plan drillings that are more likely to intersect contaminant plumes and to provide effective monitoring of plume movement. Appropriate conceptual models can also help predict future behavior and help support the design of more effective remediation and/or contaminant plume containment schemes. A good conceptual model is crucial for risk assessment and performance assessment; as such it can drive the remedy design and selection process

Proposals must address the issues of how the proposed research will provide the necessary improved understanding, will provide a foundation for new technology development for measurement and/or prediction of flow and contaminant transport and hold-up in fractured rock, and will have the potential for improving risk and performance assessments at DOE sites.

Related EM-50 work:
"Analog Site for Characterization of Fractured Rock"; *TTP#* SFl-4-10-01; Jane C. S. Long Principal Investigator; (510) 486-6697.

"Integrated Geophysical and Hydrological Characterization of Transport Through Fractured Media"; TTP# ID4-5-330-0l; James B (Buck) Sisson Principal Investigator; (208) 526-1118.
.
"3D/3C Reflection Seismic for Site Characterization"; TTP# AL9-4-l0-0l; J. C. Hasbrouck, Principal Investigator; (303) 248-6714.

Related ER-funded work:

"Imaging of Reservoirs and Fracture Systems Using Microearthquakes Induced by Hydraulic Injections"; L. House LANL (505) 667-l9l2.

"Laboratory and Theoretical Analyses of Transport Paths in Single Natural Fractures"; S. R. Brown SNLA (505) 844-0774 N. G. W. Cook et al at LBL and UC Berkeley.

"In-Situ Permeability Determination Using Borehole and Seismic Logging Data," M. Nafi Toksoz (617) 253-7852 and C. H. Arthur Cheng (6l7) 253-726, MIT.

"Models of Natural fracture Connectivity Implications for Reservoir Permeability," D. D. Pollard (415) 723-4679 and A. Aydin (415) 725-8708, Stanford University.

Description of EM-60 Need: High-Performance Gamma Radiation Sensors

Nuclear weapons production has resulted in the contamination of several DOE sites with gamma-emitting radionuclides, notably U and Pu, that are present in soils and groundwater, and in facilities and processing equipment that require deactivation, decontamination, and decommission (D&D). Many D&D activities deal with large volumes of contaminated materials such as concrete, rubbles, scrap metals, processing equipment, hot cells, and reactors. Radiation sensors are required to survey materials/sites for "hot" spots, perform real-time monitoring of waste materials to provide a feedback control of waste excavation/cleanup operations, and perform long-term monitoring (by deployment in the subsurfacce) of migration of radiological contaminants.

The present detector of choice is an alkali halide doped with thallium, e.g., sodium iodide [NaI (TI)], because of its high scintillation efficiency, linear gain proportional to energy, ruggedness, "off-the-shelf" availability in many sizes and shapes, and moderate cost. However, it has a low sensitivity adversely affected by a poor energy resolution (typically >6% at the 662 KeV line of 137Cs) and other attributed noise, and is hygroscopic. While a cooled high-resolution solid state detector, i.e., HPGe, delivers the necessary resolution and sensitivity, the storage and application of liquid nitrogen (LN2) is a severe impediment under most field conditions.

Currently, two room-temperature, solid-state detectors, HgI and CdZnTe, offer promising results and may meet performance requirements. However, they are available only in very small sizes. Proposals are sought for: 1) the development of reliable and reproducible processes to grow defect-free, large crystals of HgI and CdZnTe, and 2) new materials or detectors that offer superior performance characteristics. The required characteristics of radiation sensors include a high energy resolution (preferably <3% at 662 KeV), inertness to chemicals (including moisture) in normal operation adaptability to the robotics platform or other subsurface deployment tools such as a cone penetrometer. These sensors will be used in field operations and must require little maintenance.

Related Tasks:

Task Name	PI Name/Affiliation	PI	Phone Number
Versatile, Robust, Miniature Sized/Real Time Radiation Detector	EK. Souw,	BNL	516-282-5407
Compressed Xenon Gamma Sensor for Environmental Measurements (FY94 DOE SBIR Phase I Grant)	John Markey, Proprietor		619-282-5407
Activated Optical Ceramics: A New Class of Materials for Environmental Monitoring (FY93 DOE SBIR Phase I Grant)	Charles Brecher, ALEM Asso.		617-353-5158

EM contact for ER/EM FY1996 Research Collaboration – Stan Wolf, 301-903-7962

EM-OTD Program Manager for Characterization, Monitoring, and Sensor Technology Program – Caroline Purdy, 301-903-7672

Author of above topics: Paul Wang, Ames Lab, ph 515-294-7238
INTERNET: pwang@ameslab.gov_at_INTERNET at X 400PO

EM contact for ER/EM FY1996 Research Collaboration – Stan Wolf, 301-903-7962

EM-OTD Efficient Separations and Processing Program Manager – Teresa Fryberger, 301-903-7688

Author of above topics: William Kuhn, ph 509-372-4553
INTERNET: wl_kuhn_@ccmail.pnl.govJuly 19

Date: 7/6/95 3:52 PM
July 19

SUBJECT: SEPARATIONS PROJECTS FOR ER-EM COLLABORATION IN FY1996

Transport of tritiated water in polymer membranes

Problem Area: Facilities Decontamination –Separation of HTD from H_20

Current EM Investment: Composite membranes are being developed that will remove tritium from contaminated water at DOE sites. Aromatic polyphosphazenes were chosen as the polymeric material for the membranes being investigated because they have excellent radiological, thermal, and chemical stability. (PI: Dave Nelson; Lab: PNL; FY95 TTP: Separation of HTO

Problem: It appears that the transport of tritiated water (HTO) though a polymer membrane can be significantly different than for ordinary water. This difference is being explored as a basis for a membrane-based system for separating HTO from water. However, the mechanism for difference in transport properties is unknown. Temperature is important, and the separation appears to be strongest in the vicinity of the maximum density. Salinity also appears to have a significant effect. The exact structural features of membranes that provide or affect the separation are not known, and hence a basis for careful process control when producing a polymer for this purpose is not known. Consequently, the process is not yet considered fully credible, it can be evaluated only on the basis of mass balance results that are difficult to obtain accurately for HTO, and there is not a good basis for design of experiments and technology development is proceeding in an undesirably Edisonian fashion.

Potential BES contribution: Determine mechanism of pressure-driven transport of water in certain organic polymer (e.g. polyphaphazene) membranes, emphasizing the role of atomic weight of the water hydrogens. Develop capability to predict relative transport of H_2O and HTO as a function of temperature, key polymer properties, etc.

Colloidal behavior during solid-liquid separation of tank sludge

Problem Area: High-Level Waste in Tanks – Sludge Washing

Current EM Investment: Existing filter technologies are being tested. Settling of sludge in brines is being measured. Fundamental studies of colloid behavior in such systems has been limited, largely through discretionary funding at national labs. A laboratory for studying colloids in radioactive systems is being assembled at PNL but funding for future operations is doubtful. (PI: Dan McCabe; Lab: SRTC; FY95 TTP: unknown)

Problem: Nuclear waste stored in tanks at DOE sites such as Hanford, Savannah River, and Oak Ridge often include solid phases collectively referred to as sludge. The phases include metal oxides, carbonates, phosphates, silicates, and aluminosilicates, and various unidentified phases. The supernatant is typically a very alkaline (e.g., several molar NaOH) NaNO, brine. The solid (sludge) – liquid (supernatant) mixture needs to be washed and possibly leached using additional caustic, followed by a solid-liquid separation. The solid-liquid separation step is becoming recognized as a potentially difficult step because of the potential generation of colloids during processing. Given the multitude of solid phases involved and the extreme conditions (high ionic strength, high pH, significant changes in pH and ionic strength), understanding and predicting colloid formation and behavior in these systems is difficult.

Potential BES contribution: Determine mechanisms of generation, abatement and behavior of colloids in model systems pertinent to nuclear waste in tanks. Develop capability to predict behavior during washing or caustic leaching of sludge.

Actinide chemistry in HLW tank supernatant

Problem Area: Low-Level Waste Disposal – Actinides in storage tank supernatant

Current EM Investment: EM is working with Russian scientists to utilize their prior and current work on actinide chemistry in NaOH brines. (This is Teresa's international work. Jim Taylor at HQ should be able to provide TTP details.)

Problem: Nuclear waste stored in tanks at DOE sites such as Hanford, Savannah River, and Oak Ridge may include actinides in the alkaline supernatant complexed by carbonates or organic species. The solubility of actinides and their behavior in supernatant during solids washing operations could determine if subsequent chemical separations steps are needed before disposing of the supernatant after vitrification or incorporation in a grout, or they could affect or even from the basis of chemical separation processes. The solubilities are less well understood in alkaline solutions that in acids, i.e. carbonate complexation of TRU species.

Potential BES contribution: Augment available data and understanding about actinide solubilities in model solutions pertinent to alkaline tank waste supernatant. Data on both inorganic and organic complexation is germane.

Strontium complexation in HLW tank supernatant

Problem Area: Low-Level Waste Disposal – Actinides in storage tank supernatant

Current EM Investment: None.

Problem: Nuclear waste stored in tanks at DOE sites such as Hanford, Savannah River, and Oak Ridge may include strontium-90 complexed by organic species. The solubility of Sr and its behavior in supernatant during solids washing operations could determine if subsequent chemical separations steps are needed before disposing of the supernatant after vitrification or incorporation in a grout. If separations are needed, the form in which the Sr resides in the supernatant will determine the chemical activity of the Sr and hence be crucial to the success of potential processes such as ion exchange.

Potential BES contribution: Develop and/or confirm sophisticated but practicable (e.g., potentially on-line) methods for determining Sr speciation in presence of diverse (viz., due to radiolysis) organic complexants in model solutions pertinent to alkaline tank waste supernatant. Develop capability to predict Sr solubilities and chemical activity in likely complexant-containing tank waste supernatant.

Radiation damage in IX polymers

Problem Areas: Radionuclide separations – organic resins

Current EM Investment: As new resins are developed, they are tested for radiation stability by immersion in gamma-irradiated simulated wastes. Work is beginning on testing new resins in actual radioactive waste. No work is being funded on fundamental studies of radiation damage of resins or ligands.

Problem: Separation processes are being developed to separate Cs-137 and Sr-90 from nuclear waste solutions. The Cs and Sr irradiate the separating agent (IX resins, sorbents) and limit its useful life. (PI: Lane Bray; Lab: PNL; TTP: "Develop and Test

Potential BES contribution: Determine mechanism of radiation damage in terms of local irradiation/recoil from decay of sequestered atoms, including all pertinent decay daughters, for model polymer/ligand systems. Determine mechanism of damage from radiolysis products caused by in NaNO, brines. Develop capability to predict relative rates of damage from held Cs and Sr and from radiolysis of brine for a series of polymer and/or ligand types.

SUBJECT: Robotics Problem Areas for EM/ER Collaboration in FY1996

A. PROGRAMMING AND DESIGN GUIDELINES R&D

1. New Method for Intelligent Navigation of Mobile Platforms with Goal Directed Behavior Using Dynamic Programming

There are many potential applications for mobile platforms that have an ability to dynamically change and optimize route planning. Current methods for route planning and navigation are not well adapted to complex, large scale, real world environments. The object of this research project is to develop an intelligent tool for planning route paths that will support operation of mobile platforms in large, unstructured environments.

B. DESIGN OF MINIATURE ROBOTS USING "MEMS"

8. Power and Control Systems

Miniature robotics technology is still in its infancy, but the availability of off the shelf Micro Electro Mechanical Systems (MEMS) devices will soon allow for these systems to be built. At this time, the only MEMS actuators on the market are miniature pneumatic valves. Because the MEMS technology is so new, design guidelines for synthesizing systems using these components are needed.

C. CHARACTERIZATION AND SENSOR R&D

2. Intelligent & Automated Wear Particle Image Analysis

A great deal of interest is beginning to be focused on preventative and predictive maintenance in automation and manufacturing. Efforts are underway to develop an in-line sampling instrument which automatically analyzes and classifies images in ferrographs (the wear particles found in lubricants of rotating machinery or hydraulics). The private sector has started to investigate the in line sampling instrument, but automated morphology (shape) processing has not been achieved.

9. "Enhanced reality" Sensor Displays

This project would focus on exploring/developing sensor technologies which could provide visual information where normal vision systems don't work. A primary area of interest is developing the ability to see through smoke where combustion is present. Infrared sensors are rendered ineffective due to the heat of combustion.

10. Study of Ultrasonics Effect on Contaminant Analysis and Distillation

Primary interest is related to contaminant analysis automation, but distillation applications are present in a variety of industries including the chemical analysis, petrochemical, perfume and mining industries.

11. Automatic Specific Gravity Measurement System

Research and development an automated Specific Gravity Measurement System with application to remote hot cell operation.

12. Precision Control System

Develop control system which would be compatible with hot cell, fume hood and benchtop operation. The system would be user friendly with a touchscreen interface and would have the capability of automatic calibration and retention of calibration parameters.

D. MOBILE ROBOTS AND "TOUCH" TECHNOLOGY

3. Micro Walking Robot

These micro robots could potentially be used to inexpensively perform useful tasks such as collecting radioactive particles in contaminated facilities.

1. Locomotion on the Outside of Pipe

Many industries are interested in robots that can travel on the outside of piping to deploy sensors and detectors. External inspection often has distinct advantages over internal inspection, particularly when it is difficult of impossible to access the interior of the piping.

2. Miniaturized Stability Control System (maybe belongs in ROBOT/SENSOR FABRICATION group)

Research is needed on miniaturizing components needed to provide stability control such that they could be used on small, unmanned vehicles.

3. Foot Structures for Walking Robots

Walking robots traditionally have been outfitted with very rudimentary feet, normally a rubber button or similar endpiece. This type of foot structure may be simple, but is not designed to maximize traction on varying, irregular surfaces. As robots get smaller with respect to environmental surface regularities, the ability to achieve and maintain traction becomes increasingly important. This project would research foot structure designs that would maximize traction and compliance on a variety of surfaces.

E. ROBOT/SENSOR FABRICATION

4. Three Dimensional circuit Fabrication

As the size of miniature robots continues to shrink, the size of practical robots has begun to approach the size of the required control and drive electronics. Until now, the conventional method of fabricating electrical circuits has been to arrange the components on planar circuit boards. The 2 dimensional nature of this packaging is extremely limiting to the geometry of small robots. It is time to break away from the traditional methods of circuit fabrication and to explore ways to fabricate electrical circuitry in 3 dimensions.

EM contact for EM/ER FY1996 Research Collaboration – Stan Wolf, 301-903-7962

EM-OTD Robotics Program Manager – Linton Yarbrough, 301-903-7293

Author of above topics: burce Wilding, Ph 208 526-8160; Fax: 208 526-7688

INTERNET: wilding@pmafire.inel.gov_at_INTERNET at X400PO

Department
Germantown, MD

Date: September 7, 1995
To: Distribution
From: Office of Health and Environmental Research
Office of Energy Research
Subject: Solicitation of Research in Selected Environmental Topics

As many of you know, the Office of Energy Research (ER) and the Office of Environmental Management (EM) are engaged in a number of activities intended to strengthen the scientific and technical cooperation between the two offices. This process began in May 1994, when a joint EM/ER workshop was held. One of the key recommendations from that workshop was that ER develop basic research programs that are closely coupled to EM's research needs. In response to this, and in recognition that ER has the requisite capabilities for, and interests in, supporting the basic research needs of the EM, we are pleased to announce a research program with funding commencing in FY 1996. In Phase One, ER will fund several research projects of three year duration that address explicit basic research needs identified by EM program managers. In Phase Two, ER and EM will co-fund the initial steps in taking the results from Phase One to technology implementation. In Phase Three, EM will assume funding for the final steps of technology implementation. We believe that this program represents a very important step in expanding the increasingly effective collaboration between EM and ER.

Attached please find five statements of research areas in which we will be soliciting proposals. These topical areas were developed jointly by program managers in the Office of Technology Development (OTD, EM-50) and the Office of Health and Environmental Research (OHER, ER-70). They represent basic research that meets explicit needs of EM but that fall within the programmatic missions of ER. In FY 1996, $3,000,000 will be available to support proposals in this area; thus, we anticipate making 6-8 awards.

Initial recipients of this announcement are urged to distribute it in a timely manner to all appropriate technical staff members.

Application Process and Schedule

White Papers (Preposals)

Prior to the submission of full proposals that address the problem statements referenced above, white papers must be submitted that summarize the approach that the principal investigator(s) would propose to take for a given research topic. In preparing the white papers, please note that it is intended that significant progress towards the research goals stated in the topical solicitations-that is, towards the broad scientific understanding appropriate for an ER-supported project-will be made in three years; *the statement of response should be focused on those parts of the problem statement that the respondee feels have a reasonable chance of being addressed in such a time frame.*

The white papers will be reviewed by a team of ER and EM program managers. The investigators preparing those considered ads most responsive to the topical solicitations will be asked to submit full proposals; such proposals will, in turn, be subjected to full, external peer review.

Format for the white paper:

- *Investigators are advised that submissions exceeding the specifications of length will not be considered.* The page limits are for text in type no smaller than to point, with adequate margins (at least one-half inch) on all sides, prior to conversion to electronic form.

- Cover sheet: A sample form is attached. The cover sheet must contain the items included on that form: topic number and title for which the white paper is being submitted; name of laboratory; name of principal investigator, telephone, fax number, electronic mail address, and regular, mailing address; name of a coinvestigator, if any, with the same information; and name of the official laboratory contact person formally submitting the white paper, with telephone and electronic mail address.

- Problem Being Addressed: *No more than one-half page:* the problem being addressed; which research topic, which part(s) of that topic, and a general statement of approach to research addressing that problem.

- Approach: *No more than 15 pages:* approach; statements indicating why this approach, coupled with the chosen focus, as a high probability of achieving useful results in 3 years (or ways in which this approach is unique and should be explored in a high risk/high payoff scenario), statement of relevant experience among collaborators, and statement of facilities available for these studies.

- Investigators: *No more than one-half page for the principal investigator (no more than one-half page for a co-principal investigator, if any)*: statement of qualifications.

NOTE: NO MORE THAN SIX (6) WHITE PAPERS WILL BE ACCEPTED FROM A SINGLE NATIONAL LABORATORY. IF MORE THAN SIX ARE RECEIVED, NONE WILL BE REVIEWED.

Note, also: whereas this announcement is being sent only to National Laboratories, laboratory investigators are strongly encouraged to collaborate with academic investigators, as appropriate.

Schedule:

Monday, 10/2/95 at 5:00pm EDT: White papers due to the Office of Energy Research, at the location specified below. They may be submitted by electronic mail, by fax, or by regular mail. The preference is for electronic mail submissions, but fax or conventional mail is acceptable. If sent electronically, they should be sent as IBM-compatible WordPerfect files or as DOS ASCII files, not as Macintosh files.

- Fax to Dr. Roland Hirsch at (305)903-0567

- E-mail to roland.hirsch@oer.doc.gov
- Conventional/overnight mail:
  Dr. Roland Hirsch
  ER-73, Mail Stop F240, Room G107
  U.S. Department of Energy
  19901 Germantown Road
  Germantown, MD 20874-1290

Monday, 10/23/95: Notification made as to which white papers were selected for receipt of full proposals. *Full instructions for proposal preparation will accompany this notification.*

Friday, 10/27/95: Notification for those white papers not selected.

Monday, 12/04/95: Full proposals due to the Office of Energy Research.

Early February, 1996: Funding decisions announced.

We look forward to receiving white papers in response to the five research areas identified in the attachments.

Michelle S. Broido, Ph. D.
Acting Director,
Environmental Sciences Division
Office of Health and Environmental Research

CC: A. Patrinos, ER-70
I. Thomas, ER-10
C. Frank, EM-50
M. Krebs, ER-I
T. Grumbly, EM-1

Attachments (in ASCII text format):
- Distribution list (by fax to Laboratory Directors, by electronic mail to all)
- Form for cover sheet for white paper submission

- Five topical statements:

1. Fractured rock systems at DOE’s Hanford, INEL and ORNL Sites: Site characteristics related to site remediation.
2. Actinide and fission product chemistry in HLW tank supernatant
3. Robotics: methods for intelligent navigation of mobile platforms
4. Automation of laboratory processes
5. Sensors for measurements under extreme conditions.

Department of Energy
EM/ER Collaboration

Distribution List of September, 1995 Solicitation

Ames Laboratory:
- Dr. Thomas J. Barton, Director
- Dr. Martin Edelson
- Dr. R. Bruce Thompson

Argonne National Laboratory:
- Dr. Alan Schriesheim, Director
- Dr. Frank Y. Fradin
- Dr. Christopher A. Reilly

Brookhaven National Laboratory:
- Dr. Nicholas P. Samios, Director
- Dr. James Davenport
- Dr. Denis McWhan

Environmental Measurements Laboratory:
- Dr. Philip W. Krey, Acting Director
- Dr. Merrill Heit

Idaho National Engineering Laboratory:
- Mr. W. John Denson, President, Lockheed Idaho Technologies
- Dr. Arthur Denison
- Dr. Robert Snelling

Inhalation Toxicology Research Institute:
- Dr. Joe L. Mauderly, Director

Lawrence Berkeley National Laboratory
- Dr. Charles V. Shank, Director
- Dr. Sally Benson
- Dr. Daniel S. Chemla

Lawrence Livermore National Laboratory:
Dr. C. Bruce Tarter, Director
Dr. Jay C. Davis
Dr. Jeffrey Wadsworth

Los Alamos National Laboratory:
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Dr. Paul Gilna
Dr. Roger Pynn

National Renewable Energy Laboratory:
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Dr. Michael L. Knotek
Dr. Ray Stults

Sandia National Laboratory:
Dr. Paul Robinson, Director
Dr. J. S. Binkley
Dr. Robert Eagan
Dr. John Vitko

Stanford Synchrotron Radiation Laboratory:
Dr. Arthur Bienenstock, Director

Westinghouse Savannah River Company:
Dr. Susan Wood, Vice President and Director
Dr. Lucien Papouchado

U.S. Department of Energy
Office of Energy Research
Office of Environmental Management
FY 1996 Collaborative Research Program

White Paper/Preproposal

Deadline for receipt: October 2, 1995 at 5:00 pm EDT

Cover Sheet
(Please complete each item)

Topic number and title (from solicitation):

Name of Laboratory:

Principal Investigator:
Name:
Telephone Number:
Fax Number:
Email Address:
Mailing Address:

Co-Principal Investigator (Optional; maximum of one):
Name:
Telephone Number:
Fax Number:
Email Address:
Mailing Address:

Official Laboratory contact Formally Submitting this White Paper:
Name:
Telephone Number:
Email Address:

ER/EM Collaborative Research Solicitation: September 1995

Topic I: Fractured Rock Systems at DOE's Hanford, INEL and ORNL Sites: Site Characteristics Related to Site Remediation

Background: In both the shallow and deep subsurface, preferential flow and matrix diffusion are of concern in determining the mobility and containment of contaminants, both in aqueous and non-aqueous fluid phases, at the Hanford, Idaho and Oak Ridge Department of Energy Sites. Improved characterization of preferential flow and contaminant transport in fractured rock is needed to support decision-making pertaining to risk and performance assessment and remediation action at several DOE sites. Fundamental questions remain concerning how key physical, geologic, biogeochemical, and hydrologic factors control the flow, transport, uptake and release of contaminants. Such information is needed for establishing and testing models to predict contaminant transport, and for evaluating and implementing remediation and containment strategies.

Problem Statement: At Hanford, basalt aquifers are at risk below contaminant plumes; at INEL the basalt aquifers and interbedded sediments are now contaminated. At both sites, there is some evidence of the presence of subsurface microbial ecosystems that may assist in future in situ intrinsic remediation. Massive fractured basalt flows occur in thick flows, separated by interbeds of sediments. At Oak Ridge, contaminants are moving offsite, in surface waters and groundwater, contamination is found in the unsaturated zone, the shallow subsurface, and deep (several hundred feet) aquifer systems. Important host rocks at Oak Ridge include fractured shales that contain saprolite in the unsaturated and saturated zones.

Solicitation:

A. Characterization of Flow and Contaminant Transport in Fractured Rocks

Proposals responsive to this section will describe research building on existing data and understanding if physical properties governing contaminant transport in fractured rock, investigate mechanisms and scaling in space and time of properties affecting fluid flow in fractured rock systems, and incorporate these results in fluid-flow models. Among the key interrelated factors are the three-dimensional permeability of fractures, fracture nucleation and growth, stress distribution, material properties of the rock, and precipitation/dissolution processes, involving dissolved aqueous and non-aqueous phase species, within test and evaluate models for flow in fractures. Consideration of scale-dependent phenomena in space and time is essential in development of physically meaningful three-dimensional models for fault zone hydrology.

B. Geochemistry of Basalt/Contaminant Interactions:

Proposals responsive to this section will describe research meeting the need for basic understanding of the interactions of organic compounds (immiscible fluids and solutes) of mixed wastes containing radionuclides with solid rock surfaces. Matrix properties such as porosity, spatial distribution of mineral properties, moisture content, microscopic and macroscopic heterogeneity, etc., exert tremendous control on the diffusion and transport of dissolved constituents. Biologic activity, and the presence of biodegradation products, can significantly modify the characteristics of mineral and rock surfaces and impact predictions of reactions and transport. The success of new and innovative remediation schemes for contaminated basaltic systems will stem from a better understanding of the interactions of the host with the constituents of the wastes.

ER Contact: Dr. William C. Luth
Phone: 301-903-5822; mail: william.luch@oer.doe.gov

Dr. Paula Davidson
Phone: 301-903-5822; mail: paula.davidson@oer.doe.gov

Dr. Frank Wobber
Phone: 301-903-5549; mail: frank.wobber@oer.doe.gov

EM Contact: Dr. Caroline B. Purdy
Phone: 301-903-7672; mail: caroline.purdy@em.doe.gov

ER/EM Collaborative Research Solicitation: September 1995

Topic 2: Actinide and fission product chemistry in HLW tank supernatant

Background: Large volumes of high level nuclear waste (HLW) are currently stored in tanks at DOE sites such as Hanford, Savannah River, INEL, West Valley, and Oak Ridge. The waste, typically produced as highly acidic nitric acid solutions from nuclear reprocessing activities, was made alkaline with sodium hydroxide to prevent corrosion of the storage tanks. Over the years, a number of reprocessing schemes were used including the bismuth phosphate process, the redox process, and the Purex process. Thus, the waste solutions contain not only the broad range of actinides and fission products that are produced in a fissioning nuclear system and the concentrated salts from neutralization, but many additional chemical reagents that were added during and after chemical processing. Extensive documentation regarding composition of the high level waste is available. Under the alkaline conditions in the tanks, the actinides and most of the radioactive fission products are expected to be present predominantly as insoluble precipitates. Ultimate disposal of the waste will entail separation into low level stream while minimizing the volume of the high level stream. Initial treatment of the wastes will probably involve liquid/solids separations and washing of the solids separations and washing of the solids. A detailed understanding of the partitioning of radioactive species during these operations is crucial.

Problem Statements: The partitioning of the actinides, and other materials such as strontium, between the solid and liquid phases and during washing operations is of particular concern. Many potential complexants, both inorganic (for example carbonate) and organic (for example EDTA), are present in the tanks and will affect solubility and transport of actinides and strontium. It is, therefore, vitally important to understand the fundamental complexation reactions and speciation of these elements under the complex conditions relevant to the tank waste and subsequently encountered in separation processes. Such information is required to determine whether chemical separation steps are needed in preparing the waste for disposal, and if such steps could even form the basis of chemical separation processes to be applied to the waste.

Solicitation: Proposals responsive to this section will describe research into one or more of the following: identification and characterization of inorganic or organic chemical complexes of strontium, actinides or other materials that might be important in alkaline HLW supernatant solutions; effects of radiolysis or complexation or strontium with organic complexants; solubilities of stontium actinides, or other materials of importance under conditions relevant to HLW tank wastes.

Background Reference: DOE/EM –0249 "Efficient Separations and Processing Crosscutting Program" (Available from Waste Policy Institute, Gaithersburg, Maryland, 20878-1437; telephone 301-990-3104; Fax: 301-990-4889)

ER Contact: Dr. Harry Dewey
Phone: 301-903-5806; mail: harry.dewey@ocr.doe.gov

EM Contact: Dr. Teresa B. Fryberger
Phone: 301-903-7688; mail: teresa.fryberger@em.doe.gov

ER/EM Collaborative Research Solicitation: September 1995

Topic 3: Robotics: Methods for Intelligent Navigation of Mobile Platforms

Background: Research on the foundations of autonomous robotics systems and remote handling systems has reached the point where a relatively small amount of additional, specialized, directed basic research effort will lead to the construction of devices needed to meet the needs of the environmental clean-up program.

Beyond what is now known in this area of robotics, some additional methods and paradigms are required to enable the mobile robots to navigate and perform tasks in unstructured and dynamic environments, such as those expected to be encountered in environmental clean up tasks.

Problem Statements:

A. Autonomous model acquisition and terrain coverage

The problems of terrain coverage and model acquisition deal with systematic navigation of the robots to completely and precisely cover an unstructured area. One of the main challenges is to show analytically the completeness and convergence of the algorithm within the context of limited and error prone sensor information. Here the terrain model can be only partially known, in which case the sensor-based methods must be employed; moreover a thorough coverage requires precise navigation methods to cover the areas close to obstacles. The former calls for strategic exploration of unknown areas based only on local sensor information. The latter calls for precise motion control methods for mobile robots which could be non-holonomic.

B. Sensor processing and fusion for navigation

Typically mobile robots will be equipped with a suite of sensors, for example ultrasonic, infrared, laser range, etc. Easily computable methods with guaranteed performance are required to fuse the information from different sensor modalities or distributed sensors located on multiple robots to obtain terrain information. One of the effective methods is based on learning the fusion and processing rules from the actual sensor data obtained by sensing objects with known parameters. Here the challenge involves designing methods with performance guarantees based on small sample sizes. Furthermore, it is important that the estimators be computable in low-order polynomial time in terms of sample sizes. Such methods will alleviate the difficulties in fitting precise sensor models and expedite the process of integrating a new sensor into an existing suite after a brief training period.

Solicitation: Proposals responsive to this section will describe research into one or more of the following: three-dimensional image acquisition with enhanced speed and accuracy, faster data processing algorithms, object and image recognition systems, improved methods for three-dimensional model representation. Research in this area will focus on mobile platform navigation and operations using a variety of manipulators and end effectors.

Background Reference: DOE/EM-0250 “Robotics Technology Crosscutting Program” (Available from Waste Policy Institute, Gaithersburg, Maryland 20878-1437; telephone 301-990-3104; Fax: 301-990-4889)

ER Contact: Dr. Oscar Manley
Phone: 301-903-5822; mail: oscar.manley@ocr.doe.gov

EM Contact: Dr. Linton W. Yarbrough
Phone: 301-903-7293; mail: linton.yarbrough@em.doe.gov

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Topic 4: Automation of Laboratory Processes

Background: Automation of the measurement of chemical and physical properties provides several benefits: the results have greater precision, since the operator fatigue and inattention that plague manual analyses is eliminated; samples that are hazardous (toxic, radioactive, explosive, etc.) can be studied with less danger to personnel; more samples can be analyzed for a given operating budget, since one operator can control several automated systems simultaneously; and, not insignificantly, waste disposal problems can be greatly reduced as a robotic system can work with much smaller volumes of both reagents and samples than a human is able to manipulate. Recent developments in diverse areas ranging from micromachining to computer interfaces offer the possibility of automating extremely complex characterization procedures. In addition, automated analytical procedures can readily be integrated into the laboratory information management systems (LIMS) that are now widely used for obtaining and distributing laboratory data.

Problem Statement: The remediation of DOE's waste storage facilities and contaminated subsurface environments for which the Department is responsible is impeded by lack of information about the composition of the materials to be treated. Characterization has been impeded by: the difficulty of obtaining samples from remote locations, the lack of suitable techniques for making the required measurements, and/or the need for measuring many more samples than is essential to overcome these obstacles, but immediate attention is directed to automation of established analytical laboratory techniques that are considered critical to characterizing waste and contaminated soil samples.

Solicitation: Proposals responsive to this section will describe research into one of the following: automation of the measurement of physical properties and parameters, such as density, tensile strength, crush strength, or viscosity, in hazardous environments such as remote hot cells or high level waste storage tanks; development of automated chemistry systems based on standard methods and suitable for analysis of large numbers of highly radioactive and caustic and oxidizing liquids, using substantially reduced sample and reagent volumes. All proposals should demonstrate awareness of the requirements of LIMS and the informatics needs of the geographically widely distributed DOE waste management effort.

Background Reference: DOE/EM-0254 "Characterization, Monitoring, and Sensor Technology Crosscutting Program" (Available from Waste Policy Institute, Gaithersburg, Maryland 20878-1437; telephone 301-990-3104; Fax: 301-990-4889)

ER Contact: Dr. Roland F. Hirsch
Phone 301-903-3682; mail: roland.hirsch@ocr.doe.gov
Dr. Gerald Goldstein
Phone 301-903-5348; mail: gerald.goldstein@ocr.doe.gov

EM Contact: Dr. Linton W. Yarbrough
Phone: 301-903-7293; mail: linton.yarbrough@em.doe.gov

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Topic 5: Sensors for Measurements under Extreme Conditions

Background: Sensors for measurement of physical and chemical characteristics in remote locations have come into widespread use in recent years. Several technological advances make it possible to consider application of sensors under wide ranging conditions of temperature, pressure, and chemical composition (such as extremes of pH and salt content). These advances include (but are not limited to): selection of novel materials for the sensing elements, such as polymer composites and sol-gel ceramics; utilization of all accessible regions of the optical spectrum; application of novel solid-state devices for electrochemical sensing; and employment of sensing arrays in combination with advanced chemometric techniques to simultaneously determine multiple properties of samples.

Problem Statements: Millions of gallons of high-level radioactive waste are stored in underground tanks. These wastes consist of mixed solids, often in multiple layers formed at different times from different waste streams, in contract with concentrated salt solutions. The consistency of the solid layers varies from peanut butter to rock. The conditions in the storage tanks include pH above 12 temperatures that range from ambient to nearly 100 °C, and radiation fields of up to 5,000 rad/hr. Safety concerns include chemical reactivity (approximately half of the solids are nitrate or nitrite salts), flammability, and potential criticality.

Characterization of these wastes is required before remediation can begin. The techniques for characterization must be applicable in situ, must be able to interrogate large waste volumes (tens of liters in size) to assure that representative overall compositions are obtained and to resolve small volumes (tens of mL level) to assure that hetrogeneity of the tank composition is adequately delineated.

Solicitation: Proposals responsive to this section will describe research into one or more of the following: new sensor compositions, novel combinations of sensing devices, combinations of spectroscopic and electrochemical techniques in multiple sensor configuration, improved alogrithms for interrogating sensors in remote locations. The sensors to be designed and studied must permit measurement of at least one of the desired characteristics of the samples: water content, total organic carbon content, fissile material content, rate of hear generation, and stratigraphic layering (homogeneity or consistency of composition, including detection of buried objects). The sensors must be suitable for the use under the extreme conditions described above.

Background Reference: DOE/EM-0254 "Characterization, Monitoring, and Sensor Technology Crosscutting Program" (Available from Waste Policy Institute, Gaithersburg, Maryland, 20878-1437; telephone 301-990-3104; Fax: 301-990-4889)

ER Contact: Dr. Gerald Goldstein
Phone 301-903-5348; mail: gerald.goldstein@ocr.doe.gov

Dr. Ronald F. Hirsch
Phone 301-903-5806; mail: harry.dewey@ocr.doe.gov

Dr. Harry J. Dewey
Phone 301-903-5806; mail: harry.dewey@ocr.doe.gov

EM Contact: Dr. Caroline B. Purdy
Phone 301-903-7672; mail: caroline.purdy@em.doe.gov

Author: Michelle Broido at ER-GTN
Date: 2/14/96 10:04 AM
Priority: Normal
Receipt Requested
TO: MARK GILBERTSON at EM-06
TO: CAROL HENRY at EM-06
Subject: Wolf-Broido proposals – as requested
---Message Contents---

Proposals that have been funded:

101 Jane Long, LBNL, "Investigation of Groundwater Flow Paths in Fractured Aquifers through Combined Inversion of Strontium Isotope Ratios and Hydraulic Head Data"

102 Karsten Preuss, LBNL, "Processes Controlling the Migration and Biodegradation of Non-Aqueous Phase Liquids (NAPLs) within Fractured Rocks in the Vadose Zone"

210 David L. Clark, LANL, "Actinide Chemistry in Alkaline Radioactive Waste"

213 Marc D. Porter, Ames, "Electrochemically Transformable Extraction Phases for the Separation of Critical Metal Ion Constituents in High Level Wastes"

402 Jay Grate, PNNL, "Automation of Radiochemical Analysis by Flow Injection and

502 Donald Lucas, LBNL, "Near-Infrared Detection Methods for Complex Mixtures"

513 Peter Esherick, SNL, "Miniaturized Optical Based Sensors for Extreme Environments"

114 Jani Ingram, INEL, "Surface Chemistry of Subsurface Basalt"

The following proposal is tentatively approved for funding, pending receipt of an additional piece of information.

508 Ralph James, SNL, "Improvement of Cadmium Zinc Telluride Detectors for Use in a Gamma-Ray Imaging Spectrometer System for the In Situ Characterization of Underground Waste Tanks"