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US Department of Energy Office of Environmental Management

Office of Technology Development

A National Program

**FY 1995
Technology Development
Needs Summary**

March 1994

MASTER

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ACRONYMS

ABS	Aqueous Biphasic Separation
ACM	Asbestos Containing Material
AL	DOE Albuquerque Operations Office
ALARA	As Low As Reasonably Achievable (or Allowable)
AMES	Ames Laboratory
ANL	Argonne National Laboratory
BDAT	Best Demonstrated Available Technologies
BNL	Brookhaven National Laboratory
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CH	DOE Chicago Operations Office
CRADA	Cooperative Research and Development Agreement
CMST	Characterization, Monitoring, and Sensor Technology
CMU	Carnegie Mellon University
CUA	Catholic University of America
D&D	Decontamination and Decommissioning
DIAL	Diagnostic and Control Analytical Laboratory
DD&D	Deactivate, Decontaminate, and Decommission
DNAPL	Dense Non-Aqueous Phase Liquid
DOE	U.S. Department of Energy
DOIT	Development of On-Site Innovative Technologies
DP	Office of Defense Programs
DPM	Defense Prioritization Model
EBWR	Experimental Boiling Water Reactor
EM	Office of Environmental Restoration and Waste Management
EM-30	Office of Waste Management
EM-40	Office of Environmental Restoration
EM-50	Office of Technology Development
EM-60	Office of Facility Transition and Management
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FN	DOE Fernald Operations Office
GAC	Granulated Activated Carbon
GDP	Gaseous Diffusion Plant
GJPO	Grand Junction Project Office
GPM	Gallons Per Minute
HLW	High-Level Waste
HWPP	Hazardous Waste Pilot Plant
ID	DOE Idaho Operations Office
ID	Integrated Demonstration
INEL	Idaho National Engineering Laboratory
IP	Integrated Program
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LDUA	Light Duty Utility Arm
LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level Waste
MIT	Massachusetts Institute of Technology
MSU	Mississippi State University

ACRONYMS (Continued)

MWLID	Mixed Waste Landfill Integrated Demonstration
MWIP	Mixed Waste Integrated Program
MWPP	Mixed Waste Pilot Project
NDA	Non-Destructive Assay
NREL	National Renewable Energy Laboratory
NV	DOE Nevada Operations Office
OR	DOE Oak Ridge Operations Office
ORNL	Oak Ridge National Laboratory
OTD	Office of Technology Development
PCT	Product Consistency Test
PEG	Polyethylene Glycol
PETC	Pittsburgh Energy Technology Center
PI	Principal Investigator
PNL	Pacific Northwest Laboratory
PPE	Personal Protection Equipment
PRDA	Program Research and Development Announcement
PSU	Pennsylvania State University
PUREX	Plutonium-Uranium Extraction
R&D	Research and Development
RAD	Radiation Adsorbed Dose
RCRA	Resource Conservation and Recovery Act of 1976
RDDT&E	Research, Development, Demonstration, Testing, and Evaluation
RF	DOE Rocky Flats Operations Office
RFP	Request for Proposals
ROA	Research Opportunity Announcement
ROD	Record of Decision
RSL	Remote Sensing Laboratory
RSM	Radioactive Scrap Metal
RTDP	Robotics Technology Development Program
SBIR	Small Business Innovation Research
SB-TIP	Small Business Technology Integration Program
SCWO	Supercritical Water Oxidation
SF	DOE San Francisco Operations Office
SNL	Sandia National Laboratory - New Mexico
SNLCA	Sandia National Laboratory - California
SR	DOE Savannah River Operations Office
STRC	Savannah River Technology Center
STL	Special Technologies Laboratory
TBD	To Be Determined
TCLP	Toxicity Concentrate Leachate Procedure
TPA	Tri-Party Agreement
TPO	Technical Program Officer
TRU	Transuranic Waste
TSG	Technical Support Groups
TTP	Technical Task Plan
VOC	Volatile Organic Compound
WHC	Westinghouse Hanford Company

FOREWARD

This Technology Development Needs Summary was compiled from a January 1994 call for technical task plans to define work activities at the U. S. Department of Energy (DOE) sites. DOE's Office of Environmental Management (EM) seeks to implement its Research, Development, Demonstration, Testing, and Evaluation (RDDT&E) program by involving the best talent in the national science community. Partnerships among the National Laboratories, private industry, and academia are encouraged.

This needs summary is not a solicitation. However, DOE recommends that interested parties contact technical program coordinators and principal investigators for further information about specific programs. Please refer to section 5.0 of this document, "How to Get Involved," for details about mechanisms available for participation in the RDDT&E program. A list of available publications is also included.

SECTION 1.0

INTRODUCTION

1.0 INTRODUCTION

Historic activities of the U.S. Department of Energy (DOE) during the period of nuclear weapons development, and disposal practices of that time, resulted in the discharge of chemical and radioactive materials to the environment at many DOE facilities and sites. The Department has now focused a major technical effort on mitigating the effects of those discharges through an environmental restoration program. The unique chemicals involved and the circumstances surrounding the discharges could lead to prohibitive costs if conventional technology is applied for remedial action. In order to hold costs to an acceptable level, the Office of Environmental Restoration and Waste Management's (EM) Office of Technology Development (OTD) has been directed to initiate a national program to develop and demonstrate faster, better, cheaper, and safer means of restoring the DOE sites to conditions that will meet state and federal environment regulations. Key elements of the OTD initiative are the **Integrated Programs (IPs)** and **Integrated Demonstrations (IDs)**. These components work together to identify possible solutions to major environmental problems.

When a new technology enters the OTD Research, Development, Demonstration, Testing and Evaluation Program, an **Integrated Program** serves as a technology filter or incubator. Through bench-scale and field-scale experiments, data are produced to evaluate a technology for full-scale demonstration. An **Integrated Demonstration** is an established program at an actual site, which demonstrates, tests, and evaluates related technologies individually or as a complete system to correct waste management and environmental problems from cradle to grave. IDs are funded to maintain the necessary infrastructure to ensure that tests can be performed in a rapid and acceptable manner. Each ID demonstrates the application of all aspects of a clean-up, including characterization, assessment, remediation, and monitoring to regulators, host communities, and other stakeholders to expedite public and regulatory knowledge and acceptance of a technology.

IDs are comprised of technologies with reliable bench-scale data and full-scale demonstration capability within two years. IPs encompass technologies that require more study and further testing. A project originating in an IP may gradually move into an ID, or a Comprehensive Environmental Response, Compensation, and Liability Act of 1980 treatability study, if new data indicate that the technology is faster, better, safer, or cheaper than currently used, baseline practices.

In an effort to coordinate the environmental Research, Development, Demonstration, Testing, and Evaluation (RDDT&E) efforts within EM, joint Office of Waste Management, Environmental Restoration, OTD, and Facility Transition and Management Focus Teams were recently formed to address five problem areas:

- High-Level Waste Tank Remediation
- Mixed Waste Characterization, Treatment, and Disposal
- Landfill Stabilization
- Contaminant Plume Containment and Remediation
- Facility Transitioning, Decommissioning and Final Disposition

These Focus Teams will coordinate EM research to ensure that technology development projects address urgent end user needs and to eliminate duplication of effort. The Focus Teams will review proposals recommended for funding, coordinate the listing of site needs, and integrate EM technology development programs. Technologies developed within other DOE divisions, such as the Offices of Energy Research, Energy Efficiency, and Defense Programs, etc., and outside of DOE (academia and private industry) will be used to provide stronger scientific bases for OTD RDDT&E efforts. The goal is "seamless" technology development, from fundamental science through applied engineering, to find practical solutions to DOE's clean-up problems.

The ultimate goal of this OTD initiative is for demonstrated technologies to be available to the end user when they are needed at DOE sites. Technology transfer to private industry is an essential part of the process. Special consideration is given to activities that:

- clearly relate the outcome of the proposed work to end user needs;
- present a realistic plan for transferring technology to end users and to industry;
- emphasize applied research and development requiring less than 3 years for field demonstration;
- identify technologies developed outside DOE that require only slight reconfiguration/augmentation for use in the EM clean-up mission;
- demonstrate the direct involvement of other EM Divisions, including joint demonstration, testing and evaluation activities; and
- collaborate with National Laboratories, universities, and commercial entities.

SECTION 2.0
INTEGRATED DEMONSTRATIONS

MIXED WASTE LANDFILL
INTEGRATED DEMONSTRATION

2.1 Mixed Waste Landfill Integrated Demonstration

The Mixed Waste Landfill Integrated Demonstration (MWLID) is evaluating new technologies to clean up chemical and mixed waste landfills. This will be accomplished by emphasizing in situ technologies that minimize landfill disturbances. The MWLID approach to solving these contaminated waste site problems begins by first characterizing the source of contamination, including the types of pollutants and the precise location of the problems. Geologic and hydrologic properties must also be determined so scientists can accurately predict how the contaminants behave underground. The MWLID attempts to gather this information through new methods of drilling, ground-penetrating radar, electromagnetic measurements, and infrared thermal imagery.

New methods to remediate the landfill sites are also a major focus of the MWLID. Few in situ technologies are presently available to remediate contamination from heavy metals and complex chemical mixtures in the critical area under a landfill between the surface and the groundwater -- the "vadose zone." MWLID scientists test new extraction technologies to remove harmful metals and volatile organic wastes from soils. They seek to isolate contaminants and develop subsurface liners to better contain wastes in place. Stabilization technologies, using polymers or cements to ensure that wastes will not migrate, are examined. The "transformation process" has been recommended to change chemical forms of contaminants to reduce toxicity and/or mobility.

Since a single technology will not address all problems, the MWLID encourages the integration of mature and innovative technologies from universities, industry, and research institutes. Additionally, the MWLID is aggressively developing partnerships with these groups as well as state, local, and tribal governments in New Mexico to broaden the knowledge and use of its technology achievements.

Questions about the program can be addressed to:

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MWLID Program Manager
U.S. Department of Energy
(301) 903-7248

Jennifer Nelson
Technical Program Coordinator
Sandia National Laboratory
(505) 845-8348

NEEDS STATEMENT: ML-1**ID/IP: Mixed Waste Landfill Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.01.03****Focus Area: Landfill Containment****Description of Need: Vadose Zone Post-Closure Monitoring**

Post-closure monitoring is required for virtually all remediated sites. Standard practice monitors groundwater wells for the presence of contaminants. This approach may be problematic at a site with a relatively great depth to groundwater; at the Mixed Waste Landfill Integrated Demonstration (MWLID) sites the vadose zone extends nearly 500 feet deep. By the time contaminants are detected in the groundwater, significant vadose zone contamination may have occurred. Monitoring the vadose zone beneath the remediated site instead of the groundwater would permit earlier detection of a contaminant release, with a smaller contaminated volume, and result in a less costly additional remediation effort.

The proposed work will lead to the development of a system for post-closure monitoring in the vadose zone beneath the MWLID sites. A monitoring system will have many of the same features and technologies as the characterization system: for example, directionally drilled holes for access under the remediated site, and in situ sensors for detection of contaminant migration to minimize active maintenance and sampling. Efforts should focus on filling needs for long-term monitoring, and evaluating the feasibility and adequacy of applying available technologies to a post-closure vadose zone monitoring system. Comparison to baseline monitoring technology should be identified and used to direct development efforts. The monitoring technologies should be a modification of the technologies used during characterization. The technologies should be tailored for the contaminants of concern at landfill sites, including metals, radioactive wastes, and organics. The monitoring system must be compatible with subsurface access systems. Data acquisition should be configured for periodic, automatic query.

Window of Opportunity: FY 95 through FY 97, depending on successes and funding outlooks.**Other Applicable IDs or IPs:** Monitoring could be applicable to all IDs or IPs as a verification tool after treatment, containment or extraction of the contaminated areas.**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Post Closure Monitoring Tech Demo & Evaluation	K. Bostick (LANL)	505-665-0253	P. Saxman (AL)
Landfill Characterization \Monitoring System	B. Floran (SNL)	505-844-6268	P. Saxman (AL)
Deep Vadose Zone Moni- toring Tech Emplacement	C. Williams (SNL)	505-844-5722	P. Saxman (AL)
Borehole Permeameter for Site Monitoring	J. Sisson (INEL)	208-526-0875	T. Williams (ID)

NEEDS STATEMENT: ML-2**ID/IP: Mixed Waste Landfill Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.01.03****Focus Area: Landfill Containment****Description of Need: Containment Assessment Technologies**

Subsurface containment technologies are being developed as interim measures, in conjunction with remedial action, and as part of long-term waste containment strategy. Emplacement technologies, including permeation grouting, jet grouting, and soil-heating-based grouting, are being investigated. Grout materials under consideration include cementitious materials and thermosetting materials. The most important issue regarding the applicability of sub-surface barriers is verifying the continuity of the emplaced barrier. Techniques evaluated to date include: ground penetrating radar, cross-hole seismic tomography, electromagnetic induction, neutron probe, and down-hole temperature logs. There is a need to develop, demonstrate, and evaluate additional technologies that can be used to assess barrier continuity. Verification technologies could include non-intrusive, hydrologic and direct physical techniques. The technologies should permit continuity verification of subsurface barriers on the order of a few square meters in dry vadose zones to a depth of 10 meters. We seek technologies that have as small a resolution as possible, but at least on the order of decimeters. Technologies that require no disruption of the waste site are more desirable. In addition, technologies should be available for commercialization within two years.

Window of Opportunity: FY 95 through FY 97 depending on successes and funding outlooks.**Other Applicable IDs or IPs: Buried Waste, Underground Storage Tanks****Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Subsurface Barrier Emplacement	B. Dwyer (SNL)	505-845-9894	P. Saxman (AL)
Verification of Subsurface Barriers	W. Stewart (PNL)	509-372-0459	D. Trader (RL)

NEEDS STATEMENT: ML-3

ID/IP: Mixed Waste Landfill Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.01.03

Focus Area: Landfill Containment

Description of Need: Subsurface Containment Technologies

Landfills typically contain waste materials that include solid waste materials, such as construction debris and off-spec manufacturing intermediates or final products. Residual radioactivity and chemical contamination on these items do not warrant excavation and ex situ treatment, nor in situ stabilization treatments. Development of secondary subsurface contaminant features that modify existing subsurface conditions may provide additional contaminant mobility reduction, in combination with surface covers, to further minimize the risk of residual contamination. Technologies are sought that will provide long-term residual contaminant migration control with passive methods that may include inducing a negative subsurface water balance, or ventilation methods to reduce the build up of contaminant vapors. Small-scale field demonstrations are more desirable with data collection systems that support computational based engineering models.

Window of Opportunity: FY 95 through 97 depending on successes and funding outlooks.

Other Applicable IDs or IPs: Monitoring could be applicable to all IDs or IPs as a verification tool after treatment, containment or extraction of the contaminated areas.

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Dry Barrier Applications for Landfill	J. Stormont (SNL)	505-845-9347	P. Saxman (AL)

Table 2.1 Mixed Waste FY 94 Characterization/Monitoring Activities.

MIXED WASTE LANDFILL INTEGRATED DEMONSTRATION		
<i>Integrated Demonstration Coordinator - Jennifer E. Nelson, 505-845-8348</i>		
<i>FY 94 Characterization/Monitoring Activities</i>		
<i>Project Leader: Bob Floran, 505-844-6268</i>		
<i>Title</i>	<i>Facility</i>	<i>P I</i>
Post-Closure Monitoring Technology Demonstration and Evaluation AL-1410-01	LANL	K. Bostick 505-665-0253
Landfill Characterization & Monitoring Systems AL-2211-07	SNL	B. Floran 505-844-6268
Deep Vadose Zone Monitoring Technology Emplacement AL-2211-15	SNL	C. Williams 505-844-5722
Hybrid Directional Boring and Horizontal Logging AL-2211-16	SNL	B. Wemple 505-844-2230
Cross-Borehole Electromagnetic Imaging AL-2211-23	SNL	D. Borns 505-844-7333
Magnetometer Towed Array AL-2310-03	SNL	J. Cochran 505-848-0415
Environmental Decision Support System AL-2410-04	SNL	B. Knowlton 505-844-5777
Measurement While Drilling AL-2410-07	SNL	B. Floran 505-844-6268
Optimization of Sampling Strategies for Containment Delineation and Risk Management CH-2211-02	ANL	R. Johnson 708-972-2023
Borehole Permeameter for Site Monitoring ID-1410-02	INEL	J. Sisson 208-526-1118
In Situ Determination of Radionuclides & Metal Contaminants RL-3211-13	PNL	R. Brodzinski C. Shepard 509-376-3529
On-Site Analysis of Metals using ASV RL-3211-12	PNL	K. Olsen 509-376-4114

Table 2.2 Mixed Waste FY 94 Remediation Activities.

MIXED WASTE LANDFILL INTEGRATED DEMONSTRATION		
<i>FY 94 Remediation Activities</i>		
<i>Integrated Demonstration Coordinator - Jennifer E. Nelson, 505-845-8348</i>		
<i>Project Leaders: Extraction/Treatment</i>		<i>Jim Phelan, 505-845-9892</i>
<i>Containment/Stabilization</i>		<i>John Stormont, 505-845-9347</i>
TITLE	FACILITY	PI
Migration Barrier Covers for Mixed Waste Landfills AL-1212-11	LANL	K. Bostick 505-665-0253
Prototype DSS to Select MWL Barrier Cover Systems AL-1310-01	LANL	K. Bostick 505-665-0253
Geochemical Controls on Chromium Mobility AL-2211-08	SNL	J. Phelan 505-845-9892
Effects of Site Capping on Contaminant Transport AL-2211-11	SNL	J. Phelan 505-845-9892
Remedial Options Study AL-2211-20	SNL	J. Phelan 505-845-9892
Thermal Enhanced Vapor Extraction System AL-2211-21	SNL	J. Phelan 505-845-9892
Dry Barrier Applications for Landfills AL-2310-02	SNL	J. Stormont 505-845-9347
Subsurface Barrier Emplacement AL-2310-04	SNL	B. Dwyer 505-845-9894
Demonstration of Electrokinetics Remediation of Chromium from Unsaturated Soil AL-2410-01	SNL	E. Lindgren 505-844-3820
Advanced Landfill Cover Demonstration AL-2410-03	SNL	J. Stormont 505-845-9347
In Situ Containment and Stabilization of Buried Waste CH-3211-01	BNL	L. Kukacka 516-282-3065
Verification of Subsurface Barriers RL-4410-10	PNL/WHC	W. Stewart 509-372-0459

URANIUM IN SOILS
INTEGRATED DEMONSTRATION

2.2 Uranium in Soils Integrated Demonstration

Objective of ID:

The Integrated Demonstration develops and demonstrates methods to remediate soils contaminated with radionuclides, principally uranium. Traditional excavation, transportation, and radiological waste disposal methods are difficult and expensive, because of the large volume of soil to be treated. The ID approach establishes optimal techniques for each step in a remediation effort (e.g., real-time field characterization and monitoring, precise excavation, physical size separation, chemical treatment, disposal) as an overall system on the basis of efficiency, cost, risk, applicability range, and community/regulatory acceptance for remediation of large surface areas contaminated with uranium. The focus is on technologies for (1) real-time analysis to detect and map contaminant locations, (2) treatability studies to decontaminate soils, (3) precise excavation techniques, and (4) secondary waste treatment. These technologies will have applicability at DOE and other sites. They can be transferred potentially to Oak Ridge, Paducah, Portsmouth, Savannah River, Idaho, Los Alamos, and Richland for cleanup of radionuclide contaminated soils at these locations.

Status:

The Uranium in Soils ID was initially funded in FY 91. The Fernald Environmental Management Project (FEMP) was selected as the host site. Analysis of Fernald soil determined that the uranium exists predominately in the particulate form, associated primarily with the sand and silt fractions. Some soil also has a significant amount of uranium associated with the clay fraction. The uranium found was associated with the more dense fractions of the soil components; however, significant variations were noted. The uranium exists principally (80-90%) in the hexavalent oxidation state. In general, hexavalent uranium has greater solubility than uranium in other oxidation states.

Much of the particulate uranium exists in discrete, crystalline mineralogical phases. Uranium bearing phases identified include: (1) uranium adsorbed onto iron oxides; (2) uranium silicates; (3) uranium phosphates; (4) uranium oxides; (5) calcium uranium oxide; and (6) uranium contained within a calcium fluorite phase. Particles of uranium [IV] phases have also been identified: (1) uranium silicide and (2) uranium oxides.

Characterization of residual uranium waste forms in treated soils show a slightly higher ratio of tetravalent to hexavalent uranium. This suggests the extracts being applied are less effective at removing tetravalent uranium. There is a decrease in size of particulate hexavalent uranium. In particular, a phase identified as meta-autunite was never seen in treated soils. All treatment technologies seem to lead to a more dispersed, finer-grained contamination.

Removal of uranium from heavy textured soils by conventional soil washing (defined here as a physical separation process that relies on size fractionation and concentration of contamination in the fines) is ineffective because of the sorption of uranium on the high silt and clay content of these soils. True restoration of soils with a high fraction of fines is highly dependent on the application of a chemical extraction technique that will selectively extract uranium from soils without impairing them with serious physicochemical damage. The effectiveness of uranium extraction will depend upon how well the particular chemical reagent can contact and dissolve the specific uranium form. Extractants that alter the oxidation-reduction potential of the extraction environment may be useful in that such changes weaken crystalline structures enhancing the dissolution of uranium from mineral phases.

Treatability tests are being conducted on the following processes: (1) carbonate, citric acid and CBD (sodium citrate/sodium carbonate/sodium dithionite) leaching (ORNL); (2) aqueous biphasic separation (ABS)(ANL); extraction utilizing organic chelators (LANL); (3) the Westinghouse/SEG soil washing process; bioextraction (INEL); and (4) column leach tests to allow comparisons between batch extraction and heap leaching (LANL). The Environmental Restoration program at Fernald has been investigating sulfuric acid. Lab-scale tests (using soil initially at approximately 500 ppm uranium) resulted in the following approximate extractions: (1) 80% with carbonate (2) 65-70% with citrate (3) 95% with CBD (4) 95% with sulfuric acid (5) 80% with ABS involves the selective partitioning of either solutes or colloid-size particles between two immiscible aqueous phases (6) polyethylene glycol being one of the phases.

ABS can successfully separate particles ranging from 50 μm to 20 nm. Effectiveness is dependent upon the degree to which uranium is present as discrete particulates, 65-85% with TIRON (TIRON combined with the reducing agent dithionite was able to remove 85%). Heap leaching using potassium bicarbonate/carbonate or sodium bicarbonate/carbonate was able to remove approximately 80-85% of the uranium after a 24 hr leach. The SEG process combines physical separation equipment with ammonia carbonate extraction. SEG tests indicate uranium was soluble in sodium hypochlorite/ammonia carbonate solutions. Microorganisms indigenous to Fernald soils were investigated; however, no beneficial effects to uranium extraction were detected. Tests of the microorganism *Thiobacillus ferrooxidans*, a bacteria, show enhanced (slightly faster) sulfuric acid extractions.

In FY 93, a task was initiated to address the feasibility of treating effluent from carbonate and citric acid leaching of uranium from contaminated soil. Tests were run to determine unit processes that might apply to steps such as: (a) filtration; (b) clarification; (c) washing; (d) uranium concentration or precipitation; (e) recovery and reuse of chemicals; and to study discharge volumes and composition of solution. This effort is continuing in FY 94, with focus on dewatering soils extracted with carbonate, feasibility of removing the uranium/citric acid complex by ion exchange or chemical means, and applicability of a biodegradation/photodecomposition process for citric acid treatment developed by Brookhaven National Lab.

Prior to FY 94, investigations were not conducted on treatment of extractants from the other decontamination processes. Ability to treat the uranium impregnated extracts as well as the cost to do so is critical to the evaluation of decontamination processes. Efforts are being initiated in FY 94 to investigate the ability/cost to break the uranium-TIRON bond and recover the TIRON for recycling, the ability/cost to recycle the polyethylene glycol utilized in ABS, and the ability/cost to selectively remove the uranium from sulfuric acid while leaving the iron and other metals in solution. Treatment of the extracts is the focus of FY 95 activities.

The following field screening characterization technologies have been supported by this ID: (1) PNL surface and subsurface gamma spectroscopy, (2) AMES mobile laser ablation inductively coupled plasma-atomic emission spectroscopy, (3) PNL beta scintillation detector, and (4) LANL long range alpha detector. A FY 94 demonstration will include: (a) gamma spectroscopy, (b) mobile laser ablation inductively coupled plasma-atomic emission spectroscopy, (c) beta scintillation detector; long range alpha detector, (d) FIDDLER, (e) shielded sodium iodide detector, and (f) portable x-ray fluorescence.

FY 95 Planned Activities

- Demonstrate at the pilot/field scale soil decontamination in a batch reactor operation and in a heap leach operation using leaching agents identified as most effective in bench-scale studies.
- Demonstrate the complimentary secondary waste treatment processes for the leaching agents used to recover and concentrate the uranium in the leachate and to potentially reuse/recycle the leaching agent.
- Deselect decontamination strategies to maintain a research effort only for select techniques that offer potential for significantly improved performance.
- Conduct cost/benefit evaluations for characterization devices demonstrated during FY 94.
- Demonstrate a real-time in-field characterization device of mature development, if warranted.
- Conduct demonstration of precise excavation tool.
- Initiate evaluation of ID system: assessing limitations/range of applicability of available and demonstrated technologies, as well as implementation costs and regulatory requirements.

FY 96 Planned Activities

- Complete the evaluation of technologies demonstrated and investigated and issue final reports.
- Provide cost, efficiency, range of applicability and regulatory requirements information for technologies to needy sites. Continue facilitating the transfer of technologies into ER activities for implementation.
- Transition research-level technologies funded in FY 95 that offer promise for significant advantages to appropriate programs.

FY 95 Technology Needs

General Needs:

The ID seeks innovative real-time uranium characterization devices or decontamination technologies. The technologies should be sufficiently mature to facilitate field scale demonstration prior to the end of the fiscal year (summer of FY 95). Decontamination technologies for uranium in soil at the developmental state will be evaluated in partnership with the Efficient Separations and Processing Integrated Program.

Specific Needs: Leachate treatment technologies.

For more information contact:

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NEEDS STATEMENT: US-1**ID/IP:** Uranium in Soils Integrated Demonstration**Work Breakdown Structure Number:** 01.05.01.01.05**Focus Area:** Contaminant Plume Containment and Remediation**Description of Need:** Citric Acid Recycle

Use of citric acid for soil decontamination is very expensive compared to the other competing extractants. The ability to recycle citric acid could reduce the overall cost of chemicals and may have a substantial impact on the overall process cost. A technology is needed that can break the uranium/citrate complex down without destroying the citric acid ability to complex uranium, allowing citric acid to be further utilized for extraction purposes.

Other Applicable IDs/IPs:**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Biodegradation of Citric Acid	A.J. Francis (BNL)	516-282-4534	S. Webster (CH)
Selective Extraction/ Leaching of Uranium from Soil	C.W. Francis (ORNL)	615-547-7257	J. Moore (OR)
Effluent Treatment from Carbonate and Citric Acid	M.R. Alley (ORNL) J.A. Apps (LBL)	615-574-8003 510-486-5193	J. Moore (OR)

NEEDS STATEMENT: US-2

ID/IP: Uranium in Soils Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.01.05

Focus Area: Contaminant Plume Containment and Remediation

Description of Need: TIRON Recycle

TIRON is very expensive, compared to the other extractants being evaluated for use in treating uranium contaminated soils. The ability to recycle TIRON will reduce the overall cost of chemicals, which may have a substantial impact on the overall process cost. A technology is needed that is capable of breaking the uranium-TIRON bond without destroying the ability of TIRON to bond with uranium, therefore allowing it to be further utilized for extraction purposes.

Other Applicable IDs/IPs:

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Selective Extraction/ Leaching	J.R. Brainard (LANL)	505-667-0150	P. Saxman (AL)

NEEDS STATEMENT: US-3

ID/IP: Uranium in Soils Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.01.05

Focus Area: Contaminant Plume Containment and Remediation

Description of Need: Polyethylene Glycol (PEG) Recycle

Polyethylene glycol is used in the Aqueous Biphasic Extraction process. Immiscible aqueous solutions containing PEG are mixed with uranium contaminated soil. Following mixing, particulate uranium selectively partitions to one phase, while soil partitions to the PEG phase. Removal of soil from the PEG is difficult. A technique is needed to efficiently remove clean soil from PEG for recycle of the PEG to reduce chemical costs, to reduce secondary waste treatment/disposal burden for spent PEG solutions, and to facilitate production of clean soil suitable for landscaping purposes.

Other Applicable IDs/IPs:

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Aqueous Biphasic Treatment	D. J. Chaiko (ANL)	708-252-4399	S. Webster (CH)

VOLATILE ORGANIC COMPOUNDS - ARID
INTEGRATED DEMONSTRATION

2.3 VOC - Arid Integrated Demonstration

Introduction

The VOC-Arid ID demonstrates, tests and evaluates remedial action technologies for all phases of remediation of volatile organic compounds (VOCs) in soils and groundwater at DOE arid sites. The primary site for field demonstrations under the VOC-Arid Soils ID is Hanford. Other DOE arid sites may be used for demonstrations as appropriate. Activities that integrate demonstration projects with other environmental restoration projects at DOE arid sites, and blend funding from the two programs, are desired.

Background

It is currently believed that carbon tetrachloride (CCl_4) and chloroform residues at Hanford consist of dissolved and absorbed chemicals in the saturated zone, and adsorbed, moisture-bound and vaporized chemicals in the vadose zone. Current data suggest that 21% of the total release of CCl_4 has been lost to the atmosphere, 12% resides in the vadose zone, and 2% is dissolved in site groundwaters. Some 65% is unaccounted for at this time. There may be pockets of pure liquid chemicals (DNAPLs) present as pools trapped on impermeable strata or as tendrils in the capillary fringe. If DNAPLs are present, they have not been positively identified, but are indicated by the observation of vapor concentrations near the limit of saturation. Their continued presence would extend any cleanup activity because of their ability to serve as long-term sources of dissolved and/or vaporized contaminant. The highest concentrations of CCl_4 observed to date are associated with fine-grained sediments at a depth of 35 to 40 meters.

The VOC-Arid Soils ID team is interested in new technologies or new applications of old technologies that can drastically reduce the cost of remediating VOC contamination when compared to the baseline technology. For large DOE sites, remediation can be viewed as a three-phase process:

1. *Containment* - Measures taken to stop continued migration outward in the vadose zone, downward to the saturated zone, and outward in the saturated zone.
2. *Primary Removal* - Measures taken to remove and destroy the bulk of the contaminant mass.
3. *Long-Term Care* - Measures taken to reduce low residual contaminant levels to concentrations that pose acceptable levels of risk.

The current baseline approach for VOC contamination is to complete extraction wells in the saturated and unsaturated zones, withdraw contaminated groundwater or soil vapors, concentrate the vapors, and destroy them through combustion. For groundwater, the concentration process includes separation in an air stripper followed by adsorption on granular activated carbon (GAC). For the unsaturated zone, the vapors are concentrated directly on GAC. Destruction is accomplished through thermal regeneration of the carbon. This approach is largely responsive to the second phase of remediation. Some degree of containment is achieved through plume control, but that containment is achieved only through active pumping. Pump and treat remedies may ultimately reduce VOC residues to acceptable levels, but the time and cost associated with reaching those levels will be extensive.

As the program has begun to develop promising alternatives to the baseline technology, greater priority is being placed on approaches that will address co-contaminants of the VOCs. These

technologies could be relevant to any of the three phases of remedial action and should facilitate extraction, treatment, or immobilization of chromium, uranium, technetium or nitrate in the presence of VOCs without being incompatible with the preferred remedy for the VOCs. Since in situ technologies for VOCs have shown promise (bioremediation and in-well stripping), alternatives to pump-and-treat are of greatest interest (i.e., there is little motivation to remove uranium contaminated groundwaters and treat them after developing approaches to circumvent pumping of VOC contaminated groundwater). As a consequence, special emphasis is placed on addressing in situ or in-well treatment of co-contaminants.

Further information on the VOC Arid Soils and currently funded projects can be obtained by contacting:

David Biancosino
VOC-Arid ID Program Manager
U.S. DOE
(301) 903-7961

Steve Stein
Technical Program Coordinator
Pacific Northwest Laboratory
(206) 528-3340

Tom Brouns
PNL Program Manager
VOC-Arid ID
(509) 376-7855

NEEDS STATEMENT: VA-1**ID/IP: VOC-Arid Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.01.02****Focus Area: Contaminant Plume Containment and Remediation****Description of Need: Enhanced Removal of VOCs**

Improvements in baseline technologies are needed for primary removal of VOCs and co-contaminants in the saturated and unsaturated zones. At the host site, it is currently believed that carbon tetrachloride (CCl₄) and chloroform residues consist of dissolved and absorbed chemicals in the saturated zone below 200 feet ground-level, and adsorbed, moisture-bound, and vaporized chemicals in the 200 foot thick vadose zone. The current baseline approach for VOC contamination is to complete extraction wells in the saturated and unsaturated zones, withdraw contaminated groundwater or soil vapors, concentrate the vapors, and destroy them through combustion. Vapor extraction systems are currently in use where VOC vapors are pulled from extraction wells and contaminants are then loaded in granulated activated carbon (GAC) canisters. Water treatment is currently planned using pump-and-treat methods, which also involve the use of GACs or above-ground air stripping systems for removing the contaminants.

Barring effective means of physical, chemical, thermal or biological destruction in place, technologies are sought for a means of improving the extraction of chemical contaminants from the saturated and unsaturated zone. Emphasis is placed on low permeability media and non-aqueous phase (DNAPL) residuals for which the baseline is particularly ineffective and improvements are needed. A remediation technology is needed to remove and collect subsurface DNAPL fluids without having to know their exact location, since there are no economic means for locating DNAPL pools at this time. There may be pockets of pure liquid chemicals present as pools trapped on impermeable strata or as tendrils in the capillary fringe. If DNAPLs are present, they have not been positively identified, but are indicated by the observation of vapor concentrations near the limit of saturation. Drilling for DNAPLs in suspect areas is not acceptable, due to the possibility of mobilizing the contaminants and spreading them over larger areas. Currently funded efforts for enhanced extraction of VOCs include soil heating by the use of radio frequency and ohmic heating. The use of surfactants to enhance dissolution of DNAPLs is also being studied.

Other Applicable IDs/IPs: DNAPLs, MWLID**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Arid Engineering Systems	M. Schlender (PNL)	509-376-8795	D. Trader (RL)
DNAPL Remediation Using Foams	B. Peters (ANL)	708-252-7773	S. Webster (CH)
Characterization & Evaluation Method for Passive Control	J. Allwine (PNL) S. Tomich (PNL)	509-376-8145 509-376-9645	D. Trader (RL)

NEEDS STATEMENT: VA-2

ID/IP: VOC-Arid Integrated Demonstration

Work Breakdown Sstructure Number: 01.05.01.01.02

Focus Area: Contaminant Plume Containment and Remediation

Description of Need: Improved Off-Gas Treatment of VOCs

Improvements on contaminant treatment (separation and/or destruction technologies) are needed for VOC vapor streams from other remediation technologies in place of using granulated activated carbon canisters. Tunable hybrid plasma and corona destruction are being evaluated for destruction of vapors from vacuum extraction or in-well vapor stripping systems. Treatment systems that are cost effective and that completely treat primary and secondary wastes (acid byproducts) are desired. The plasma destruction and membrane separation processes are considered representative of free radical and selective membrane approaches in general. As such, low priority is placed on other similar technologies as opposed to completely new concepts.

Other Applicable IDs/IPs:

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Off-Gas Membrane Separation	C. King (WHC)	509-373-2967	D. Trader (RL)
Tunable Hybrid Plasma	D. Cohn (MIT) T. Brouns	617-253-5524 509-376-7855	D. Trader (RL)
Off-Gas Corona Destruction	B. Heath (PNL)	509-376-0554	D. Trader (RL)

NEEDS STATEMENT: VA-3**ID/IP: VOC-Arid Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.01.02****Focus Area: Contaminant Plume Containment and Remediation****Description of Need: In Situ Destruction of VOCs**

Low energy technologies are needed that provide long-term care using measures to reduce low residual contaminant levels to concentrations that pose acceptable levels of risk. These measures should provide for low cost, low maintenance control of low concentrations of VOCs in soil and groundwater, as well as a better understanding of natural attenuation mechanisms that may reduce the need for active measures during the last phase of remediation. New concepts are needed that will provide a means of cost-effectively destroying VOCs in place and thus eliminating the need to remove, concentrate, and dispose of the contaminant and/or associated chemicals.

A remediation technology is needed to destroy DNAPL fluids without having to know their exact location, since there are no economic means for locating DNAPL pools at this time. At the host site, it is currently believed that carbon tetrachloride (CCl₄) and chloroform residues exist as non-aqueous phase liquids in the saturated zone below 200 feet ground level, and in the 200 foot thick vadose zone. There may be pockets of pure liquid chemicals present as pools trapped on impermeable strata or as tendrils in the capillary fringe. If DNAPLs are present, they have not been positively identified, but are indicated by the observation of vapor concentrations near the limit of saturation. Drilling for DNAPL in suspect areas is not acceptable, due to the possibility of mobilizing the contaminants and spreading them over larger areas.

Ongoing projects in bioremediation and in situ corona destruction are directed to that goal. Chemical reagents suffer the same mass transport limitations as extraction and may face opposition from regulators. Techniques that are not as susceptible to mass transport limitations, such as those that apply energy, will be of higher priority.

Other Applicable IDs/IPs: In Situ Remediation IP**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
In Situ Bioremediation of CCl ₄	R. Skeen (PNL)	509-376-6371	D. Trader (RL)
Characterization & Evaluation Method for Passive Control	J. Allwine (PNL)	509-376-8145	D. Trader (RL)
In Situ Corona	R. Moss (PNL)	509-376-4658	D. Trader (RL)

NEEDS STATEMENT: VA-4**ID/IP: VOC-Arid Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.01.02****Focus Area: Contaminant Plume Containment and Remediation****Description of Need: In Situ Treatment of Co-Contaminants**

Remediation technologies are needed for in situ or in-well treatment that will address co-contaminants of VOCs in groundwater and the vadose zone. The primary co-contaminants at the VOC-Arid ID host site include technetium (TC_{99}), uranium (U_{238} , U_{235}), chromium ($\text{CR}+6$), and nitrate (NO_3). Treatment technologies for co-contaminants could be relevant to any phase of remedial action and should facilitate extraction, treatment, or immobilization of chromium, uranium, technetium or nitrate in the presence of VOCs, without being incompatible with the preferred remedy for the VOCs. At the host site, it is currently believed that carbon tetrachloride (CCl_4) and chloroform residues with the co-contaminants consist of dissolved and absorbed chemicals in the saturated zone below 200 feet ground level. Special emphasis is placed on groundwater contamination from these contaminant mixtures. Greater priority within the VOC-Arid ID is being placed on approaches that will address these co-contaminants of the VOCs.

Other Applicable IDs/IPs: In Situ Remediation Integrated Project**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
In Situ Bioremediation	D. Anderson (PNL)	509-376-9428	D. Trader (RL)
In-Well Vapor Stripping	S. Gorelick (Stanford)	415-725-2950	
In Situ Chemical Treatment	E. Thornton (WHC)	509-376-6107	D. Trader (RL)
In Situ Redox Manipulation	J. Fruchter (PNL)	509-376-3937	D. Trader (RL)
In-Well Separation	B. Siegrist (ORNL)	615-574-7286	J. Moore (OR)

NEEDS STATEMENT: VA-5**ID/IP: VOC-Arid Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.01.02****Focus Area: Contaminant Plume Containment and Remediation****Description of Need: Natural Phenomena Destruction/Removal of VOCs**

Remediation technologies are needed that could use ambient thermal or solar energy or similar phenomena to control and collect VOCs over long periods of time without requiring excessive resources. At the host site, it is currently believed that carbon tetrachloride (CCl₄) and chloroform residues consist of dissolved and absorbed chemicals in the saturated zone below 200 feet ground level, and adsorbed, moisture-bound and vaporized chemical in the 200 foot thick vadose zone. If in-place destruction cannot be achieved, approaches to long-term control/care are sought. An evaluation of the effect of barometric events on atmospheric, soil surface, and soil subsurface vapor movement is currently under way. Other related activities include passive and active control of cased well heads for enhanced removal of VOCs, subsurface pressure differential and multi-layer well casing packers to target removal of VOCs from zones of higher permeability, and surface disturbance using surface modification or barriers for enhanced surface removal of VOCs.

Other Applicable IDs/IPs: In Situ Remediation IP**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Characterization & Evaluation Method for Passive Control	S. Ballard (SNL)	505-844-6293	P. Saxman (AL)
Arid Barometric Pumping	N. Rosenberg (LANL)	505-665-0183	P. Saxman (AL)
Arid Passive Venting	W. Downs (INEL)	208-526-0754	T. Williams (ID)
Arid Enhanced Passive Soil Vapor Extraction	J. Shinn (LLNL)	510-532-8203	R. Scott (SF)
Passive Control of VOCs Using Barometrically Pumped Wells	J. Rossabi (SRTC)	803-725-5220	M. O'Rear (SR)

NEEDS STATEMENT: VA-6**ID/IP: VOC-Arid Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.01.02****Focus Area: Contaminant Plume Containment and Remediation****Description of Need: Subsurface Access Technologies**

Subsurface access technologies are needed for much less expensive placement of characterization tools by faster and/or cheaper drilling or other subsurface access techniques. At the host site, it is currently believed that carbon tetrachloride (CCl₄) and chloroform residues consist of dissolved and absorbed chemicals in the saturated zone below 200 feet ground level, and adsorbed, moisture-bound and vaporized chemical in the 200 foot thick vadose zone. Since installing new wells is extremely costly, novel methods for extending the use of existing wells, such as sidewall coring for soil characterization and vapor monitoring, is desired. These methods would include minimally invasive soil sampling techniques for new or existing steel cased wells.

Other Applicable IDs/IPs: CMST-IP, MWLID**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPQ</u>
Sonic Drilling	G. McLellan (WHC) J. Wise (SNL)	509-376-2260 505-844-6359	D. Trader (RL) P. Saxman (AL)
Cone Penetrometer	G. McLellan (WHC)	509-376-2260	D. Trader (RL)

NEEDS STATEMENT: VA-7**ID/IP: VOC-Arid Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.01.02****Focus Area: Contaminant Plume Containment and Remediation****Description of Need: Methodologies for Well Placement**

Methodologies are needed for systematic decision-making regarding the placement of monitoring and remediation wells. Current procedures are inadequately rigorous. At the host site, it is currently believed that carbon tetrachloride (CCl₄) and chloroform residues consist of dissolved and absorbed chemicals in the saturated zone below 200-foot ground level, and adsorbed, moisture-bound and vaporized chemical in the 200-foot thick vadose zone. Conceptual contaminant plume maps have been made from empirical data obtained from samples during well drilling. New methodologies for decision-making might include remote sensing, surface geophysics, or enhanced numerical prediction tools. Most computer models and other software tools have already been utilized, or knowledge of their applicability to arid sites exists.

Other Applicable IDs/IPs: CMST-IP, MWLID**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Data Fusion	R. Lewis (PNL) S. Tomich (PNL)	509-376-9789 509-376-9645	D. Trader (RL)
Engineering Simulator	K. Roberson (PNL)	509-376-3514	D. Trader (RL)
Cross-hole Seismic Tomography	G. Elbring (SNL)	505-844-4904	P. Saxman (AL)

NEEDS STATEMENT: VA-8

ID/IP: VOC-Arid Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.01.02

Focus Area: Contaminant Plume Containment and Remediation

Description of Need: Locating DNAPLs

Geophysical techniques, tracer test technology, or other appropriate techniques are needed for the description of subsurface changes in saturation and location of dense non-aqueous phase liquids (DNAPLs). Emphasis is on minimally invasive techniques, or those that use existing steel cased wells. Location of the size and extent of DNAPLs is a very high priority. At the host site, it is currently believed that carbon tetrachloride (CCl_4) and chloroform residues consist of dissolved and absorbed chemicals in the saturated zone below 200 feet ground level, and adsorbed, moisture-bound and vaporized chemical in the 200 foot thick vadose zone. There may be pockets of pure liquid chemicals present as pools trapped on impermeable strata or as tendrils in the capillary fringe. If DNAPLs are present, they have not been positively identified but are indicated by the observation of vapor concentrations near the limit of saturation.

Other Applicable IDs/IPs: In Situ Remediation IP

Currently Related Tasks: None

NEEDS STATEMENT: VA-9

ID/IP: VOC-Arid Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.01.02

Focus Area: Contaminant Plume Containment and Remediation

Description of Need: Subsurface groundwater movement/detection

Technologies are needed for the measurement of circulation field and groundwater flow velocity and direction in support of in situ vapor stripping and bioremediation projects. Emphasis for this need is on sensor/monitoring devices that can be placed using less costly subsurface access techniques, such as a cone penetrometer to depths ranging from 150 to 300 feet. Current cone penetrometer technology can only allow for sensor packages smaller than 0.9 inches in diameter. Existing steel-cased wells with diameters from 4 to 8 inches may be utilized for non-invasive technologies, such as seismic or radar.

Other Applicable IDs/IPs: CMST-IP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Cross-hole Tomography	G. Elbring (SNL)	505-844-4904	P. Saxman (AL)
Groundwater Flow Sensor	S. Ballard (SNL)	505-844-6293	P. Saxman (AL)

NEEDS STATEMENT: VA-10

ID/IP: VOC-Arid Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.01.02

Focus Area: Plume

Description of Need: Off-Gas Monitoring

Methodologies are needed for the monitoring of off-gas treatment products from high energy destruction of chlorinated VOCs. Focus is on both the development or use of commercially available sampling interfaces for functioning in highly corrosive environments, as well as analytical characterization and/or monitoring techniques. Particular target analyses include, but are not limited to, phosgene and dichloroacetyl chloride.

Other Applicable IDs/IPs: CMST-IP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Tunable Hybrid Plasma	Dan Cohn (MIT)	617-253-5524	D. Trader (RL)
Off-Gas Corona Destruction	B. Heath (PNL)	509-376-0554	D. Trader (RL)

DECONTAMINATION AND DECOMMISSIONING OF FACILITIES
INTEGRATED DEMONSTRATION

2.4 Decontamination and Decommissioning of Facilities Integrated Demonstration

Mission

The Decontamination and Decommissioning of Facilities (D&D) Integrated Demonstration will (1) improve, adapt, develop, demonstrate and implement processes that will provide a total systems approach to the transitioning, decommissioning and final disposition of facilities and sites across the Department of Energy complex; and (2) develop a comprehensive system of characterization, decontamination, dismantlement, recycle, and disposition processes that are available for the transitioning, decommissioning, and final disposition of facilities and sites.

FY 94 Program

The Decontamination and Decommissioning of Facilities Integration Demonstration started in FY 94. These activities are currently underway:

- Recycle of contaminated stainless steel at Savannah River Site.
- Surface decontamination/removal of concrete using a microwave process at Oak Ridge Site.
- Bulk/volumetric decontamination of concrete using an electro-osmotic process at Hanford Site.

FY 95 Program

Deactivation, decommissioning, and recycle needs:

- Contaminated Concrete Recycle
- Fuel Storage
- Gaseous Diffusion Plant
- Lithium Processing
- Contaminated Metals Recycle
- Plutonium Processing - Deinventory
- Plutonium Processing - Equipment
- Reactors
- Uranium Processing - Systems
- Uranium Processing - Asbestos
- Characterization for Deactivation and Decommissioning

- Decontamination
- Dismantlement
- Robotics and Automation for Deactivation and Decommissioning
- Systems Studies

All suggested TTPs should include assessments of available technologies resulting from a thorough search of private industry and technical literature. TTPs should employ enhanced technologies for private industry, or utilize industrial partnerships to provide solutions to technology needs. Researchers will be expected to help develop technology transfer plans for commercialization of their technologies.

Contacts:

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Oak Ridge TN 37831-7172
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NEEDS STATEMENT: DD-1

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning and Final Disposition

Description of Need: Internal Radioactive Contamination Detection (Characterization)

A method is needed for performing non-destructive, in situ, measurements to detect radioactive contamination inside enclosed volumes. These volumes may include, but are not limited to, pipes, ducts, and process equipment. Contaminants of primary interest include alpha emitters and low-energy beta emitters. The exteriors of these volumes are often inaccessible, so internal technologies are much preferred to external technologies. Systems with large dynamic range (i.e., four to six orders of magnitude) are preferred.

R&D Objectives:

Measurement technologies must be demonstrated both in the laboratory and on actual contaminated volumes in the field. Resources are often limited in decommissioned buildings, so stand alone devices are preferable.

The D&D Integrated Demonstration prefers to fund the development of versatile radiation measurement systems that can perform, with minor modifications, in a variety of demonstration projects. This technology need was identified by the Fuel Reprocessing, Gaseous Diffusion Plants, Hot Cells, Plutonium Facilities Deactivation and Equipment Integrated Demonstrations.

Window of Opportunity: FY 95 - 96

Other Applicable IDs/IPs: CMST, Robotics D&D IP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Robotics D&D	W. Hamel (ORNL)	615-574-5691	J. Moore (OR)

NEEDS STATEMENT: DD-2**ID/IP:** Decontamination and Decommissioning of Facilities Integrated Demonstration**Work Breakdown Structure Number:** 01.05.01.02.03**Focus Area:** Facility Transitioning, Decommissioning, and Final Disposition**Description of Need:** In Situ, Real-Time Radiation Measurement Systems (Characterization)

The D&D Integrated Demonstration has a need for in situ, real-time radiation measurement systems to support field measurements of tritium, plutonium, uranium, thorium, technetium, transuranic elements, and/or fission products such as Sr_{90} and Cs_{137} . These systems need to have real-time response, be usable in the field to support decontamination activities, and meet or exceed present state-of-the-art measurement qualities, such as ease of use, ruggedness, reliability, and reproducibility.

Window of Opportunity: FY 95 - 98**Other Applicable IDs/IPs:** CMST-IP, BWID, USTID**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Rapid Transuranic Monitor System	G. Loomis (INEL)	208-526-9208	T. Williams (ID)
Electrothermal Hollow Cathode Discharge Spectrometry	S. Weeks (AMES)	515-294-7953	S. Webster (CH)
Long-Range Alpha Detector	D. MacArthur (LANL)	505-667-8943	P. Saxman (AL)
Mobile ICP Spectrometry	A. D'Silva (AMES)	515-294-9317	S. Webster (CH)

* Note: The U-Process Systems is interested in becoming the host ID.

NEEDS STATEMENT: DD-3**ID/IP:** Decontamination and Decommissioning of Facilities Integrated Demonstration**Work Breakdown Structure Number:** 01.05.01.02.03**Focus Area:** Facility Transitioning, Decommissioning, and Final Disposition**Description of Need:** Improved Technologies for Metals Cutting (Dismantlement)

Dismantlement of nuclear material processing facilities at DOE sites is a major safety, environmental, and cost concern. A wide variety of materials and physical dimensions are represented. Many facilities present the challenge of restricted access and high radiation fields, and necessarily require remote, robotic and automated systems to complete the dismantlement.

Technology Needs:

Technologies need to be developed and demonstrated that improve the state-of-the-art for metal cutting (or alternative techniques for size reduction, such as shredding). The dismantlement phase of D&D requires much cutting of stainless and carbon steels (with occasional massive steel forging and castings) as well as composite materials of layers of steel and other materials. In particular, more efficient cutting of steels is required in the dismantlement of fuel reprocessing facilities, fuel storage facilities, reactors, hot cells and GDP facilities. These improved techniques shall encompass both thermal and non-thermal techniques. Applications of improved technologies shall consider both cutting in air and in water. Underwater cutting must be capable at depths of up to 40 feet with metal thicknesses up to 6-inches for reactor vessels, or for up to 14-inches for castings or forging from heavy process equipment.

R&D Objectives:

The proposed R&D should develop new technologies and advance the existing technologies as described in the Technology Needs Statement. Improved non-thermal and thermal technologies are expected. Efficiencies of underwater cutting are expected to be improved. Cutting of composite materials that are representative in the DOE complex shall be demonstrated both in air and water as applicable. Off-gas and debris controls system demonstrations shall also be considered.

Window of Opportunity:**Other Applicable IDs/IPs:****Currently Related Tasks:** None

NEEDS STATEMENT: DD-4

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Lead Removal Tooling (Dismantlement)

Dismantlement of nuclear material processing facilities at DOE sites is a major safety, environmental, and cost concern. A wide variety of materials and physical dimensions are represented. Many facilities present the challenge of restricted access and high radiation fields, and necessarily require remote, robotic and automated systems to complete the dismantlement.

Technology Needs:

In the past, lead has been used for shielding at many nuclear facilities. The lead was usually installed as sheets or bricks, or sometimes cast in place. Since the lead functioned as shielding, it was almost always used in areas that were highly irradiated, and therefore often contaminated. In some cases the lead was cast in annuli or between steel pipes.

R&D Objectives:

There is a need to develop efficient and safe techniques for cutting lead and for separating it from other materials. Lead is soft and tends to plug saws and grinding wheels. Flame cutting procedures are undesirable because of fumes that are produced. Since lead is a hazardous material, it is important that cutting techniques minimize the spread of contamination.

Window of Opportunity:**Other Applicable IDs/IPs:**

Currently Related Tasks: None

NEEDS STATEMENT: DD-5

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Remote Disassembly, Gripper and Component Handling System for Highly Radioactive Equipment (Dismantlement)

Dismantlement of nuclear material processing facilities at DOE sites is a major safety, environmental, and cost concern. A wide variety of materials and physical dimensions are represented. Many facilities present the challenge of restricted access and high radiation fields, and necessarily require remote, robotic, and automated systems to complete the dismantlement.

Technology Needs:

A part of the dismantling of nuclear facilities, such as reactors, fuel storage basins, hot cells and fuel reprocessing facilities, it is necessary to perform remote mechanical disassembly, remove components or associated structures, and handle highly radioactive debris that is present or is produced by cutting operations.

R&D Objectives:

A remotely operated system providing a medley of basic tools (screw drivers, wrenches and others) will be developed. Metal shears are needed to cut metal structures such as I-beams. A gripper is needed for picking up components weighing from a few pounds to several hundred pounds. A system for collecting component segments and debris must be provided. Provisions should be included for direct transfer of small debris into containers appropriate for storage and/or shipping.

The tooling system must be capable of operating in air or under water at depths of up to 40 feet. Provisions must be made for rapid repair and maintenance. The overall design of the system should allow for easy decontamination and reuse at other facilities.

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks:

NEEDS STATEMENT: DD-6**ID/IP:** Decontamination and Decommissioning of Facilities Integrated Demonstration**Work Breakdown Structure Number:** 01.05.01.02.03**Focus Area:** Facility Transitioning, Decommissioning, and Final Disposition**Description of Need:** Concrete Bulk Characterization (Concrete)

Contaminated concrete represents a significant media requiring D&D at all DOE sites. Costs associated with D&D and disposal are a major concern. A wide variety of surface, subsurface, and volumetric contaminants are represented, including radionuclides and hazardous chemicals (both heavy metals and organics). In some areas, there is restricted accessibility and/or high radiation fields.

Methods for real-time, in situ, characterization of radiological contaminants in bulk concrete are needed. Many radioactive contaminants can penetrate into the volume of the concrete, so surface characterization methods will not give a true indication of the contamination level of the bulk concrete. Both alpha- and/or beta-gamma-emitting contaminants may be present in the concrete (note: this Needs Statement is focused only on bulk contamination of concrete).

R&D Objectives:

Characterization technologies will be demonstrated in field conditions on contaminated concrete. The technology should be applicable to widespread use on diverse concrete structures. Proposed work should include plans to commercialize the technology for future use.

Window of Opportunity:**Other Applicable IDs/IPs:****Currently Related Tasks:** None

NEEDS STATEMENT: DD-7**ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.03****Focus Area: Facility Transitioning, Decommissioning, and Final Disposition****Description of Need: Decontamination of Concrete Surfaces (Concrete)**

Contaminated concrete represents significant media requiring D&D at all DOE sites. Costs associated with D&D and disposal are a major concern. A wide variety of surface, subsurface, and volumetric contaminants are represented, including radionuclides, and hazardous chemicals (both heavy metals and organics). In some areas there is restricted accessibility and/or high radiation fields.

Technology Needs:

Technologies need to be developed and demonstrated for both concrete surface decontamination and volumetric decontamination of concrete. Surface decontamination technologies include techniques that address contaminated floors, walls, columns, ceilings, etc. Hot cells, fuel reprocessing areas (including canyons), reactor biological shields, gaseous diffusion plant building structures, and facilities handling mercury (lithium facilities) and tritium are included. Technologies that are capable of remote operation in high radiation areas are desirable.

Volumetric contamination of concrete has occurred in many facilities throughout the DOE complex from spills and association with various chemical and hazardous materials. The proposed volumetric demonstration should address both in situ and ex situ decontamination techniques. The in situ effort must address large-scale volumetric decontamination of concrete prior to disassembly of the concrete structure. The ex situ effort must address large-scale decontamination of concrete structures after disassembly. This ex situ demonstration shall consider size reduction of the concrete rubble and concrete rubble decontamination. Techniques similar to soil washing should be considered for ex situ concrete decontamination.

R&D Objectives:

The proposed R&D should develop technologies for at least one of the following areas: (1) removal of contaminants from near the surface of concrete (e.g., by an electrical potential) without disturbing the surface of the concrete; or (2) removing the contaminated surface of the concrete followed by ex situ decontamination of the removed concrete rubble. Technology demonstration must address collection of removed concrete, recycle (preferred) or treatment of secondary wastes, and treatment of off-gases including any vacuum systems. Surfaces should be decontaminated so that they will meet the requirements of NUREG 1.86 for release of radiological material, and applicable standards for hazardous materials.

The proposed R&D should develop technologies to improve the state-of-the-art methods for surface and volumetric decontamination of concrete. Decontamination factors shall be calculated showing ability to decontaminate concrete, using various methods for various contaminants and levels of contamination that are representative across the DOE complex.

The Principal Investigator for this effort will function as a lead technical planner/coordinator to assist the D&D ID with planning and coordinating the development and demonstration activities. It is envisioned that this will entail a number of activities at several DOE sites involving several commercial participants.

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks: None

NEEDS STATEMENT: DD-8**ID/IP:** Decontamination and Decommissioning of Facilities Integrated Demonstration**Work Breakdown Structure Number:** 01.05.01.02.03**Focus Area:** Facility Transitioning, Decommissioning, and Final Disposition**Description of Need:** Dismantlement - Improved Cutting Methods (Concrete)

Contaminated concrete represents a significant media requiring D&D at all DOE sites. Costs associated with D&D and disposal are a major concern. A wide variety of surface, subsurface, and volumetric contaminants are represented, including radionuclides and hazardous chemicals (both heavy metals and organics). In some areas there is restricted accessibility and/or high radiation fields.

Technology Needs:

Technologies need to be developed and demonstrated for improved cutting methods for the dismantlement of concrete structures. Conventional techniques have difficulty confining and segregating contaminated portions of concrete rubble and resulting dust. Additional problems include worker exposure to high radiation fields, industrial safety hazards, and generation of secondary waste. Development needs include improved methods of concrete cutting and size reduction. These methods include, but are not limited to, laser ablation, water jet, explosive cutting, expansive grout, liquid gas cutting, and diamond saws.

R&D Objectives:

For FY 95, work will focus on (1) generating detailed specifications for desirable improvements in cutting methods; (2) issuing a Request for Proposal (RFP) to industry calling for proposals for developing/demonstrating improvements; and (3) analyzing, ranking, and preparing recommendations regarding received proposals. Work will be carried through to a demonstration phase at DOE sites. It is assumed that existing technology will be applied as much as possible with limited specific technology development as necessary. The technology should be applied to waste forms that simulate the expected DOE materials, with initial work using surrogate (non-radioactive) materials.

Window of Opportunity:**Other Applicable IDs/IPs:****Currently Related Tasks:** None

NEEDS STATEMENT: DD-9**ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.03****Focus Area: Facility Transitioning, Decommissioning, and Final Disposition****Description of Need: In Situ Surface Decontamination of Equipment Exteriors (Decontamination)**

Technologies need to be developed and demonstrated to decontaminate the exteriors of nuclear facility equipment during FY 95 and FY 96. The equipment will be decontaminated in place at a DOE facility (in situ). Types of facilities include fuel reprocessing facilities, uranium processing facilities, plutonium processing facilities and gaseous diffusion plants. Typical equipment construction is of stainless steel, although other materials have been utilized.

R&D Objectives:

The proposed R&D should develop technologies to remove contamination from the exterior surfaces of nuclear facility equipment. The range of contaminants include radiological (plutonium, uranium, mixed fission products) and hazardous (corrosives, PCBs, oils, heavy metals, volatile organics) materials. Contamination levels range from barely detectable to that requiring remote handling. Equipment should be decontaminated to radioactive dose levels that do not require remote handling. Remaining hazardous contaminants should meet allowable land disposal requirements. Technologies that are capable of decontaminating equipment surfaces to meet free release standards are highly desirable. Technologies that minimize secondary waste generation are also desirable. Secondary wastes generated must be compatible with current waste disposal techniques and also be compatible with future waste disposal activities (grout, vitrification).

Window of Opportunity:**Other Applicable IDs/IPs:****Currently Related Tasks:**

A field demonstration is possible at the Fernald Environmental Management Project (FEMP). This is an ongoing environmental restoration project currently engaged in decontamination activities. Other opportunities exist at the Idaho National Engineering Laboratory Fuel Dissolution Process plant and the Waste Calcining Facility.

NEEDS STATEMENT: DD-10**ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.03****Focus Area: Facility Transitioning, Decommissioning, and Final Disposition****Description of Need: In Situ Flushing Decontamination of Equipment Interiors (Decontamination)**

Technologies need to be developed and demonstrated for the decontamination of the interior of nuclear facility equipment. The equipment will be decontaminated in place at a DOE facility (in-situ). Types of facilities include fuel reprocessing facilities (canyons), uranium processing facilities, gaseous diffusion plants, and plutonium processing facilities. Typical equipment construction is of stainless steel, although other materials have been utilized.

R&D Objectives:

The proposed R&D should develop technologies that remove contamination from the interior surfaces of nuclear facility equipment. The range of contaminants include radiological (plutonium, uranium, mixed fission products) and hazardous (corrosives, PCBs, oils, volatile organics, and heavy metals) materials. Contamination levels range from barely detectable to that requiring remote handling. Equipment should be decontaminated to radioactive dose levels that do not require remote handling. Remaining hazardous contaminants should meet allowable land disposal requirements. Technologies that are capable of decontaminating equipment surfaces to meet free release standards are highly desirable. Technologies that minimize secondary waste generation are also desirable. Secondary wastes generated must be compatible with current waste disposal techniques and also be compatible with future waste disposal activities (grout, vitrification).

Window of Opportunity:

Based upon current EM-60 schedules, field demonstrations are possible at the Hanford PUREX plant in FY 95 and FY 96. A maximum of two plutonium/uranium feed storage tanks and three waste disposal tanks will be available for decontamination demonstrations. Plutonium solution stabilization activities at Rocky Flats will provide another favorable situation for the demonstration of this technology.

Other Applicable IDs/IPs:**Currently Related Tasks:**

A field demonstration is possible at FEMP. This is an ongoing environmental restoration project currently engaged in decontamination activities. Other opportunities exist at the Idaho National Engineering Laboratory Fuel Dissolution Process Plant. Plutonium solution stabilization activities at Rocky Flats will provide another favorable situation for the demonstration of this technology.

NEEDS STATEMENT: DD-11**ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.03****Focus Area: Facility Transitioning, Decommissioning, and Final Disposition****Description of Need: Dry In Situ Decontamination of Interior Equipment Surfaces
(Decontamination)**

Certain complex applications require surface decontamination of areas where the use of bulk aqueous solutions is a particular problem. Specific examples of these are gloveboxes or other equipment in plutonium or enriched-uranium facilities where nuclear safety constraints apply, and applications where contaminated liquids may lead to uncontrolled migration of contamination, such as unlined hot cells. Decontamination techniques that are inherently dry or do not require the use of bulk liquids will substantially avoid these problems. Some "dry" techniques, while proven in certain applications, have yet to be deployed in a physically constrained or remote environment; additionally, attendant problems with control of resulting dusts remains unresolved. The interiors of process equipment to which this problem applies contain radioactive contaminants and both hazardous organics and heavy metals. A successful demonstration of decontamination using dry methods, while of overwhelming benefit to only selected D&D problem areas, has the potential of broad applicability to other DOE complex D&D problems.

R&D Objectives:

A successful technology will address the problem of dry decontamination in confined spaces, such as gloveboxes or hot cells, on a systems basis. The technology will demonstrate the capability to decontaminate various surfaces, such as stainless steel, concrete, gasketed areas, plastics, irregular surfaces, corroded areas, and complex shapes. Appropriate measures of the rate and degree of decontamination achieved will be shown based on surface and/or subsurface contamination removal. A successful approach will provide ease of application, use in hard-to-reach or remote areas, and removal or control of resulting contaminant-rich material. The approach will address either the use of multiple decontamination techniques, or the interaction or synergy between it and other decontamination techniques.

Integrated with the performance demonstration of the dry decontamination technologies, the plan must address the system of dust control. The technology will demonstrate control of dust at the source (i.e. at the point of aggressive decontamination), through local ventilation control, protection of glovebox or cell high efficiency particulate air (HEPA) filters, possible general dust suppression approaches, or a combination of the above. The system will address means to minimize spread or recontamination from dust generation and pluggage of HEPA filters leading to reduced airflow and increased filter differential pressure. The system must be evaluated based on its applicability to various levels of dust loading.

The expected deliverable will be a deployable system comprised of equipment necessary to perform the above objectives and suitable for use in a highly contaminated environment. The results of the field testing of such a system will be documented in a report detailing the efficiency of the decontamination, success of the dust control approach, and applicability of the systems to the various sites programs based on an early evaluation of their specific needs. The FY 95 scope will include the development of criteria and conceptual design of the system, bringing in the different requirements as necessary to address the site-specific needs.

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks: None

NEEDS STATEMENT: DD-12**ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.03****Focus Area: Facility Transitioning, Decommissioning, and Final Disposition****Description of Need: Ex Situ Surface Decontamination (Decontamination)**

A need exists for decontamination technologies to remove surface contamination from equipment from surplus nuclear facilities. In some circumstances, ex situ decontamination can take advantage of economies of scale, and can more easily achieve surface release decontamination levels. The contaminated equipment is metal of varying shapes, sizes, and complexity; most is stainless steel or iron. Nickel-lined steel is the most common material of construction at the gaseous diffusion plants. The contaminated equipment comes from surplus fuel reprocessing facilities, gaseous diffusion plants, hot cells, plutonium de-inventory and handling equipment, and uranium processing systems. Contamination levels range from barely detectable to that requiring remote handling. It is desired to decontaminate the equipment to levels that would allow it to be recycled or disposed of in a sanitary landfill, rather than a mixed or radioactive waste disposal site. The equipment is contaminated to varying levels with a wide range of radioactive isotopes, and, to a lesser extent, hazardous materials. Radioactive contaminants include the full range of fission products (e.g., cesium and strontium isotopes), activation products (e.g., cobalt and iron), and plutonium and uranium isotopes.

Hazardous materials can encompass the spectrum of heavy metals including lead, chrome, mercury, and cadmium. Hazardous organics such as PCBs may also be encountered, particularly at the gaseous diffusion plants.

R&D Objectives:

The proposed R&D should develop improved technology for surface decontamination of disassembled, contaminated equipment. The technology must be cost effective and critically safe with minimal risk of exposure to workers, the public, or the environment to radioactive or hazardous materials. Decontaminated equipment should meet the release standards in NUREG 1.86. The technology should minimize secondary wastes. Technology should be included to treat all wastes to a form suitable for disposal. The ultimate objective of this task is to fabricate and demonstrate the proposed technology on a pilot scale as part of the integrated demonstration and to dispose of all generated wastes. As part of this effort, it will be necessary to ensure that unique site-specific requirements will be appropriately addressed.

Window of Opportunity:**Other Applicable IDs/IPs:****Currently Related Tasks: None**

NEEDS STATEMENT: DD-13

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Improved, Reusable Modular Containment Systems (Decontamination)

Technologies need to be developed and demonstrated for the use of containment systems that could be readily decontaminated and reused in the same or other facilities. During the decontamination process, containment systems are employed to prevent the spread of contaminants during the work. These systems are currently erected for each job location and then demobilized, resulting in the generation of contaminated wastes. It is envisioned that reusable systems would reduce total waste generation, result in more economic containment implementation (customized design not required), and through standardized design result in more reliable contamination containment.

Decontamination activities often fall into two categories: localized containment of individual pieces of equipment, and use of a central area to perform decontamination work for many pieces of equipment. Throughout DOE, a variety of facilities require support of this technology, including the gaseous diffusion plant facilities, hot cell processes, plutonium processing facilities, and uranium processing facilities. Improved containment systems would have wide applicability throughout these facilities.

R&D Objectives:

Any proposed R&D should develop technologies for improved and reusable (readily decontaminated) containment systems. The systems should be designed for localized and centralized decontamination applications. The systems must be designed for easy decontamination and should be easy to put up and take down. Proposed designs should include utility and ventilation connections and allow for negative pressure work. Materials of construction should be investigated for durability and ease of decontamination, as well as considerations of nuclear hardening for higher radiation field applications. Costs of proposed systems should compare favorably with current methods of containment.

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks: None

NEEDS STATEMENT: DD-14

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Treatment of Pool Water and Sludge (Fuel Storage)

Improved processes are required to process pool water, pool sludge and sludge slurry. Current processes used to process water and sludge include: (1) clean and filter the water for reuse; (2) treat the water by evaporation, filtration and solidification; (3) vacuum and pump the soft sludge; (4) remove the hard sludge by sluicing or sparging or by physical removal; (5) dry the sludge in barrels for burial; or (6) solidify, box (in barrels), and bury sludge.

R&D Objectives:

The proposed plan should address a process to (1) improve worker safety; (2) produce clean water and clean dirt as end products; (3) generate little or no secondary contaminated waste; (4) reduce worker exposure; (5) separate hazardous and radiological material from the bulk material; (6) filter the contaminated water while pumping out the pool; (7) remove, reduce the volume, and concentrate the sludge from a remote location; (8) reduce the volume and toxicity concentration of the waste produced; (9) meet permit requirements, tritium standards, and drinking water standards; and (10) break hazardous materials down to their basic elemental form. A three-to-four year effort is envisioned.

A proposed plan should develop the process in five phases:

- Phase 1:* Identify process requirements and prepare conceptual design.
Deliverable - Concept Design Report
- Phase 2:* Prepare detailed design.
Deliverable - Detailed Design Report
- Phase 3:* Purchase equipment and construct the modular process.
Deliverable - Startup Test Report
- Phase 4:* Test the process under cold conditions; analyze and report results.
Deliverable - Cold Test Report
- Phase 5:* Test the process under hot conditions; analyze and report results.
Deliverable - Hot Test Report

Window of Opportunity:

The deactivation and decommissioning of N Reactor at Hanford is the initial target. The current schedule would require the completion of this project by April 1998.

Other Applicable IDs/IPs: Efficient Separations and Processing Integrated Program

Currently Related Tasks: None

NEEDS STATEMENT: DD-15

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Surface Characterization of Wet (Underwater) Concrete (Fuel Storage)

There is a need for in situ, real-time, radiological characterization of underwater concrete surfaces. These contaminants could include, but are not limited to, fission products, corrosion products, fuel segments, uranium, plutonium, cobalt-60, strontium, and tritium. Adoption of current instruments and technologies is encouraged.

R&D Objectives:

The objectives of this project are (1) select a conceptual design to address the need; (2) procure and/or fabricate the instrument(s); and (3) test the instruments in an underwater environment on actual radiological contaminants. Two deliverables will be required. A Technology Status Report must be submitted within sixty days describing the state-of-the-art, any environmental limitations, and the conceptual design of the proposed instrument. A Hot Test Report will summarize the results of the test objectives and test results to date.

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks: Off-shore petroleum characterization
Salvage and bomb disposal characterization

NEEDS STATEMENT: DD-16

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: NDA technologies to support D&D; improved, reusable modular containment systems (Gaseous Diffusion Plants)

Gaseous diffusion plant equipment is inherently contaminated with U, and, in some cases, fission products (primarily Tc). The use of Non-Destructive Assay (NDA) technologies (e.g. gamma spectroscopies, neutron activation analysis) has been classically used to determine the amount of uranium deposits (hold-up) that are present in the piping and process equipment. The use of models to determine absorption and matrix effects in combination with various experimental design criteria has allowed these measurements to be semi-quantitative. It is known that sometimes the error on the measurement of the amount of uranium present can be greater than 100% of the actual value. In support of D&D, not only is it important to know the amount of uranium present, but it is important to be able to monitor the removal of the uranium by in situ decontamination methods.

R&D Objectives:

The objective of this project is to optimize existing software and hardware needed to perform repetitive measurements on duplicate configurations of equipment. This information will be used to ensure that the in situ decontamination system is optimized for the removal of the uranium product. Models for specific pieces of process equipment need to be developed to provide accurate and reproducible measurements. Systems are needed to monitor the decontamination process and to predict the removal of the total uranium deposit. FY 95 activities should focus on parameter selection and improved modeling for NDA studies.

This technology development program will provide a full-scale demonstration of NDA systems to provide analysis of complex structures. An anticipated four-year project will include the procurement and design of a mobile NDA "platform" that would provide direct support to the D&D activities at the GDPs.

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Gas Phase Demonstration Program	R.D. Bundy (ORNL)	615-576-0192	J. Moore (OR)

NEEDS STATEMENT: DD-17

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Field Demonstration of In Situ Decontamination Technology (Gaseous Diffusion Plants)

The gaseous diffusion plant (GDP) process equipment is inherently contaminated with U, and, in some cases, fission products (primarily Tc). The three GDP facilities in the DOE complex represent over 10,000 stages of processing equipment (compressors, converters, valving, and piping). The ability to decontaminate the equipment in situ prior to dismantlement and disassembly will greatly reduce the radiological risks and waste generation.

It is anticipated that this project will perform a field demonstration on a single cell (8-12 stages) of GDP process equipment at one of the GDP sites. The project will focus more on demonstrating the decontamination technique and less on designing and developing a fully deployable system. The results from this field demonstration should provide insight into the full-scale application of the demonstrated technology. This program will provide a full-scale demonstration of in situ decontamination techniques for GDP process equipment. Preference will be given to activities that take full advantage of existing equipment and staff (operations, training, and permits).

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks: In situ, long-term, low-temperature gas phase decontamination technologies are currently being developed at the K-25 Site (Oak Ridge) by EM-40 (D&D Technologies Implementation Project).

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Gas Phase Decontamination Program	R.D. Bundy (ORNL)	615-576-0192	J. Moore (OR)

NEEDS STATEMENT: DD-18

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Remotely Operable, Equipment Size Reduction Tool Technology Development (Dismantlement)

Dismantlement of nuclear material processing facilities at DOE sites is a major safety, environmental, and cost concern. A wide variety of materials and physical dimensions are represented. Many facilities have restricted access and high radiation fields that require remote, robotic, and automated systems to complete the dismantlement.

Technology Need:

There is a need for improved tools to cut, shred, section, and dismantle processing equipment (plutonium processing ducts, gloveboxes and tanks). Adaptions of current tools and techniques are encouraged. The proposed plan will focus on tools and techniques that can be used effectively in a controlled sectioning or worksite size reduction environment in either the manual (generally hand held) mode, the manual support mode, or as end-effectors on more sophisticated delivery platforms.

Current types of tooling include cutting (cold, hot), glass handling, and lifting/rigging. The proposed plan will evaluate tools and techniques based on these factors: (1) ability to support more extensive segregation (increased cutting); (2) levels of contamination remaining after decontamination; (3) usefulness of water walled (double walled) gloveboxes; and (4) usefulness of standard metal shop tools and self-contained duct cutting options.

- R&D Objectives:**
1. Select conceptual designs to address the need.
 2. Procure and/or fabricate the tools.
 3. Test the tools in a glovebox environment on actual radiological contaminants.

Two deliverables will be required, including (1) a Technology Status Report, to be submitted within sixty days, describing the state-of-the art, any environmental limitations, and the conceptual designs of the proposed tools; and (2) a Hot Test Report summarizing the test objectives and the test results.

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks: None

NEEDS STATEMENT: DD-19

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Liquid Handling for Plutonium Solutions (Plutonium - Deactivation)

Facilities previously used for the aqueous processing of plutonium compounds may contain accountable quantities of plutonium within process equipment piping, tankage, and other equipment, either as residual liquids or as deposits. Deinventory and system flushing operations are expected to generate substantial quantities of liquids.

Technology Need:

There is a need for a portable, modular unit that can be moved to the location for flushing and initial liquid treatment to avoid reactivation of substantial systems equipment. This unit would save significant time and money.

R&D Objectives:

A successful system would be designed to handle liquids resulting from unprocessed recovery solutions, pipe and duct cleaning, glovebox decontamination, glovebox internals cleaning, tank cleanout, dust suppression, etc. It must deal with plutonium concentrations from a maximum of 100 gm/l to very low concentrations, and must handle a limited range of aqueous solutions with acid, caustic, foaming, and slurry characteristics. It must address nuclear safety concerns. The unit will need to be modular, small, and portable, to maneuver in process areas and support, incorporate, and complement the appropriate facility safety systems. Methods will be considered that would allow sampling and reuse/recycle of liquids such as precipitation/filtration, evaporation, and handling of resultant solids. Low-level liquid disposal (i.e. 10⁻⁴ gm/l Pu) should be assumed.

The proposed plan should consist of three phases:

Phase 1: Develop system criteria, evaluate approaches, identify facility interface methods and requirements, and develop conceptual design; interface with applicable DOE sites at various stages to ensure complex-wide applicability.

Phase 2: Design and procure prototype system.

Phase 3: Test system in a hot environment.

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks: None

NEEDS STATEMENT: DD-20

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Dry In Situ Decontamination of Interior Equipment Surfaces (Plutonium - Equipment)

Certain complex applications require surface decontamination of areas where the use of bulk aqueous solutions is a particular problem. Specific examples are gloveboxes or other equipment in plutonium or enriched uranium facilities where nuclear safety constraints apply, and applications where contaminated liquids may lead to uncontrolled migration of contamination, such as unlined hot cells. Decontamination techniques that are inherently dry or do not require the use of bulk liquids will substantially avoid these problems. Some "dry" techniques, while proven in certain applications, have yet to be deployed in a physically constrained or remote environment; additionally, attendant problems with control of resulting dusts remains unresolved. The successful demonstration of decontamination using dry methods, while of overwhelming benefit to only selected D&D problem areas, has the potential of broad applicability to other DOE complex D&D problems.

The interiors of process equipment to which this problem applies contain radioactive contaminants and both hazardous organics and heavy metals.

R&D Objectives:

A successful technology will address the problem of dry decontamination in confined spaces, such as gloveboxes or hot cells, on a systems basis. The technology will demonstrate the capability to decontaminate various surfaces, such as stainless steel, concrete, gasketed areas, plastics, irregular surfaces, corroded areas, and complex shapes. Appropriate measures of the rate and degree of decontamination achieved will be shown based on surface and/or subsurface contamination removal. A successful approach will provide ease of application, ability to be used in hard-to-reach or remote areas, and removal or control of resulting contaminant-rich material. The approach will address either the use of multiple decontamination techniques, or the interaction or synergy between it and other decontamination techniques.

Integrated with the performance demonstration of the dry decontamination technologies, the plan must address the system of dust control. The technology will demonstrate control of dust at the source (i.e. at the point of aggressive decontamination), through local ventilation control, protection of glovebox or cell HEPA filters, possible general dust suppression approaches, or a combination of the above. The system will address means to minimize spread or recontamination from dust generation and pluggage of HEPA filters, leading to reduced airflow and increased filter differential pressure. The system must be evaluated based on its applicability to various levels of dust loading.

The expected deliverable will be a deployable system comprised of the equipment necessary to perform the above objectives and suitable for use in a highly contaminated environment. The results of the field testing of such a system will be documented in a report detailing the efficiency of the decontamination, success of the dust control approach, and applicability of these systems to various sites' programs based on an early evaluation of their specific needs.

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks: None

NEEDS STATEMENT: DD-21

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Glovebox Sectioning, Transport, and Large-Scale Demonstration (Plutonium - Equipment)

There are currently hundreds of plutonium-contaminated gloveboxes and other pieces of process equipment in the DOE complex that will need to be decontaminated and size-reduced in the coming decades. The current approach decontaminates these gloveboxes for accountability and worker safety purposes only, size-reduces them in place, and disposes of the resulting pieces as TRU waste. Given the magnitude of the current D&D inventory of gloveboxes and limited TRU disposition options, this is no longer acceptable. The concept of a centralized facility for decontamination and size reduction may reduce labor costs and TRU waste volumes. In order to utilize such a facility, equipment must be isolated and initially size-reduced for transport ("sectioned"), and transported to the centralized facility. Centralized facilities for decontamination and size reduction have been used in the past, with certain problems.

Technology Need:

Three specific tasks have been identified in an effort to address these problems:

- Task 1:** Develop equipment and techniques to improve the environment to support equipment section and initial worksite size reduction. This work is currently performed in enclosures or plastic "tents" in which workers wearing supplied air plastic suits perform work involving contamination levels in excess of 1,000,000 DPM. Areas of difficulty include flexibility of enclosures for use in constrained locations, and of enclosure decontamination and reuse, equipment and personnel entry and exit, fume and dust control, ventilation control, and interface between inside work and outside support.
- Task 2:** Transport equipment items from the dismantlement worksite to other locations where decontamination, size reduction, waste packaging, and other such functions will be performed. Such transportation of contaminated equipment generates secondary waste; it also involves the movement of large (bulky and heavy) pieces of contaminated equipment through both physically constrained and open-air routes (with no building to act as a secondary containment enclosure).
- Task 3:** Demonstrate a systems approach that combines existing small-scale techniques with appropriate large-scale equipment and safety systems to decontaminate with whole or large sections of gloveboxes and other process equipment in a single, controlled process. Decontamination techniques for glovebox pieces that will consistently reduce these pieces to non-TRU, and, in some cases, even releasable levels have been demonstrated. However, due to criticality constraints they have only been demonstrated on relatively small pieces. To produce these small pieces from the

larger sectioned pieces requires labor intensive and somewhat dangerous manual size reduction.

R&D Objectives:

Task 1: **Sectioning Enclosure Improvements.** This task focuses on adapting current tools and techniques in the areas of enclosure construction, equipment entry and exit, personnel entry and exit, and ventilation. Candidate or example equipment and techniques are (1) contamination control/dust suppression (showers, novel applications of strippable coatings); (2) fume control (local and at exhaust filters, prefilters versus electrostatic precipitators); (3) interface between the inside and the outside (glovebox arrangements, pass throughs, radios, televisions, windows); (4) mobile, semi-permanent, and disposable enclosures; (5) personnel and material exit contamination control (showers); (6) reduced secondary waste (packaging, suits, tenting); (7) ventilation (airflow versus pressure differential, exhaust blowers, interfaces with facility ventilation); (8) improved worker personnel protection (greater degree of contamination protection, reduced heat stress).

Other technologies that can achieve equivalent results will be considered. The project will select conceptual designs to address the need, procure and/or fabricate enclosures, and test the enclosures and equipment in a working environment with actual radiological contaminants.

Task 2: **Total Material Handling System.** System requirements and design criteria will be developed for a wide range of facilities and equipment. Extensive involvement of industry through equipment procurement and/or research and development contracts is expected. Overall systems integration of the material handling subsystem into a working mobile transport system should be addressed explicitly. Selection of a demonstration site with a detailed plan for the test and evaluation of the prototype system must be provided. The system will be demonstrated in a actual plutonium deactivation operation. The test and evaluation plan should include provisions for the technical performance evaluation, as well as an assessment of the cost/benefit merits of the concept.

Task 3: **Achieve a Working System.** This multi-year effort will cover initial studies, prototype development, and hot testing. The final technical requirement will meet the necessary safety criteria for use at all DOE plutonium facilities. The system must demonstrate consistent ability to decontaminate to below TRU levels of contamination, to handle multiple configurations, and to produce significant reduction in manual activities in high contamination environments. This will include working examples of all pieces of equipment, procedures, and systems engineering to integrate with preparatory operations, support systems, and subsequent waste handling.

Phase 1: Activities are needed to define the project in detail. Deliverable: A task plan and a detailed request for proposals for industrial development to support subsequent phases. This effort will (a) identify candidate organizations and technologies, (b) define task criteria, (c) identify all site-specific requirements to support the use of

this approach at each applicable DOE site, (d) develop a systems study to identify feed, pretreatment and support system, and waste handling requirements, (e) produce a conceptual design applicable to each task, (f) involve the public and industry, and (g) issue a Request for Proposal through the site-specific procurement organizations.

Phase 2: The second phase, if executed, will consist of additional design (if necessary), procurement, industrial development, and prototype testing of candidate technologies and equipment.

Phase 3: The third phase will consist of a hot demonstration of the system(s), possibly at the host site. It is anticipated that this demonstration would take place in conjunction with an ongoing D&D project involving gloveboxes, and would utilize an existing canyon, cell, or other highly contaminated control area.

Window of Opportunity:

Plutonium facilities at the Rocky Flats Plant, Los Alamos National Laboratory, and the Savannah River Site involve ongoing deactivation activities. Proposed activities must begin in the FY 95 - 96 timeframe to support the initiation of plutonium facilities decontamination actions and design of TRU waste handling facilities.

Other Applicable IDs/IPs: EM-50 Robotics Technology Development Program

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Robotics D&D	W. Hamel (ORNL)	615-574-5691	J. Moore (OR)

NEEDS STATEMENT: DD-22**ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.03****Focus Area: Facility Transitioning, Decommissioning, and Final Disposition****Description of Need: Massive Equipment Size Reduction and Removal (Dismantlement)**

Contaminated equipment used to process depleted and low-enriched uranium represents a significant D&D problem for many DOE sites. Cost associated with D&D and disposal of this equipment is a major concern. A wide variety of surface and subsurface contaminants are represented, including radionuclides and hazardous chemicals (both heavy metals and organics). Several representative sites with significant near-term D&D plans are Fernald (where D&D is at an advanced state of planning), Rocky Flats (which is initiating D&D planning), and GDPs (which are planning various activities).

R&D Objectives:

The massive equipment tooling for removal and size reduction technology need must address the deficiencies of large-scale manual removal of massive equipment and its subsequent size reduction. Current methods are labor intensive, and subject workers to risk of exposure to contamination and industrial hazards. Large quantities of massive equipment will have to be removed, size-reduced, and safely handled from old and decaying DOE field locations.

Developments from remotely operable, equipment size reduction tool technology development will be scaled up to address this need. Developments from remote disassembly, gripper, and small component handling systems for highly radioactive equipment will be incorporated. Large end effectors interfacing will be defined.

The proposed solution should automate the removal, size reduction, and subsequent safe handling of massive equipment for all potential locations. Some low levels of radiological hazards should always be assumed to be present. Maximum benefits of the proposed technology should be worker safety and contamination control. The size reduction portion will particularly affect the need for contamination control from the operations. The first year effort should focus on determining the feasibility of technology and defining the best technology to apply to subsequent demonstrations. A three-year maximum technology demonstration with potential continued funding based on technical progress is the goal. The FY 95 effort should address designing the best available and future needed technology for this application. The subsequent years will address the lab and field demonstration of the best technology.

Window of Opportunity:

D&D implementation at the Fernald Site is already underway with CERCLA Removal Actions. Detailed D&D planning and technology treatability studies to support the CERCLA Record of Decision (ROD) (draft due in FY 97) have also commenced in the EM-40 program, providing an excellent opportunity for EM-40/EM-50 teaming in the FY 95 through FY 99 timeframe.

Other Applicable IDs/IPs:**Currently Related Tasks: None**

NEEDS STATEMENT: DD-23**ID/IP:** Decontamination and Decommissioning of Facilities Integrated Demonstration**Work Breakdown Structure Number:** 01.05.01.02.03**Focus Area:** Facility Transitioning, Decommissioning, and Final Disposition**Description of Need:** Dismantlement Tooling Delivery System - Reactor Vessel Components (Reactor)

Dismantlement of nuclear reactors with cylindrical metal vessels and internal metal components is a major safety, environmental, and cost concern. A variety of facilities at DOE sites have similar remote dismantlement criteria and requirements, but may also have certain dissimilar facility characteristics. Restricted access and high radiation fields necessarily require remote, robotic, and automated systems to perform tasks required to complete the dismantlement.

Technology Needs:

In the past, customized, facility-specific tooling was designed to dismantle each reactor system. Development and deployment of this tooling was costly and time consuming. In addition, a significant amount of manual dismantlement using long handled tools resulted in excessive, undesired radiation exposure to personnel. An automated and remote system is needed to deliver the specific tooling needed to perform the dismantlement task at the required location. The delivery system will need to be capable of changing out end effectors to inspect, map, collect samples, cut metal and vacuum fine debris either under water or in air. The system will reach, extend, and provide the computer software or manually operated instrument control motions required to accomplish the tasks.

R&D Objectives:

The proposed R&D should develop new technologies and/or advance the existing technologies. The end objective should demonstrate the successful operation of a generic reactor dismantlement end effector delivery system that can be cleaned, packaged, and transported to other DOE reactor sites for reuse. The system's design features will allow use of a single, reusable system at all DOE metal vessel reactors requiring dismantlement.

Secondary objectives are (1) to evaluate DOE fuel reprocessing, fuel storage pools, or other overhead access facilities within the complex that could be dismantled using this overhead delivery system with only minimal system modifications, (2) to coordinate with other related TTP, CRADA, PRDA, end effector design, or other tasks to assure compatibility and interface requirements, and (3) evaluate applicability and potential use in commercial power reactor applications.

Window of Opportunity:

Argonne National Laboratory, near Chicago, Illinois, is currently dismantling the Experimental Boiling Water Reactor (EBWR), and has a tentative schedule for two additional EM-40-funded reactor D&D projects in the late 1990's. One project, the CP-5 reactor, is considered a suitable site for the reactor integrated demonstration. These sites are suitable for demonstrating the EM-50 Integrated Demonstration process, and, more specifically, for demonstrating the reactor dismantlement system.

Other Applicable IDs/IPs:

Currently Related Tasks: None

NEEDS STATEMENT: DD-24

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Fines Removal System - Reactor Vessel Bottom (Reactor)

Reactors undergoing dismantlement may be filled with water to provide shielding. During dismantlement activities, hazardous and activated fines (e.g. sludge, dirt, corrosion products, and activated cutting debris) may accumulate on the bottom of the vessel. These fines need to be removed to maintain water clarity, minimize the spread of contamination, and facilitate activities during the dismantlement process.

Technology Needs:

A system is needed to remove the fines from the bottoms of reactor vessels.

R&D Objective:

Modular portable system design should take into consideration high radiation fields (typically > 100R) and fines removal at water depths up to 50 feet. The only components to be inserted into the vessel will be the suction tool (lance) and associated water transfer lines. The system should address collection, fines removal, and recycle of the water back to the reactor vessel. Use of the water recycle system to sparge debris from the reactor vessel should be an option. Shielding and monitoring issues for the water collection, filtration, particulate (sludge), and water recycle systems must be addressed. The overall system design should ensure minimization of secondary waste generation with minimum needs for operator interaction (e.g. sludge containment, sludge handling, sludge disposal, and routine contact), and should allow for easy decontamination and reuse of the system at other facilities.

Window of Opportunity:

Other Applicable IDs/IPs:

Currently Related Tasks: None

NEEDS STATEMENT: DD-25

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Evaluation of Robotic Compatibility and Deployment (Robotics/Automation)

Remote deployment of characterization, decontamination, and dismantlement capabilities has been identified as a need throughout the proposed D&D ID activities. Existing products and technology development activities have been identified for a wide range of characterization sensors and sampling systems, decontamination processes, and dismantlement tooling systems. DOE OTD has several robotic development activities ongoing to produce remote/robotic deployment capabilities to support the D&D characterization, decontamination, and dismantlement requirements.

R&D Objectives:

The proposed R&D will evaluate robotic compatibility of the characterization, decontamination, and dismantlement systems. This includes actual interfacing of existing or developmental D&D sensors, processes or tooling with existing robotic hardware systems to evaluate robotic compatibility, and establish interface requirements and standards to apply to future remotely/robotically deployed D&D systems. Evaluations must determine support and logistics requirements needed to realistically and effectively deploy such systems for a variety of D&D scenarios, based on the specific D&D activities identified within the D&D ID demonstration descriptions.

This is anticipated to be a two-to-three year activity. The focus for FY 95 activities will be to establish interface standards, initial determination of the support and logistics requirements for robotic deployment, and evaluations of actual robotic compatibility using existing sensors, processes, or tooling deployed from existing OTD robotic systems. Out-year activities will focus on establishing robotic deployment compatibility for characterization and decontamination and dismantlement capabilities under consideration or development by the D&D ID.

Window of Opportunity:

The OTD Robotics Technology Development Program will have several candidate deployment systems available by the end of FY 94. These will include a dual-arm manipulation module deployable from an overhead telescoping mast or a vehicle, a mobile sensor platform initially configured for floor characterization, an internal pipe crawler system for pipe of 3-inch diameter, and an internal duct crawler system. A mobile D&D vehicle system will be available from an OTD PRDA with Carnegie Mellon University by the end of calendar 1994.

Other Applicable IDs/IPs: Robotics Technology Development Program (RTDP)

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
RTDP	D&D Coordinator W. Hamel (ORNL)	615-574-5691	J. Moore (OR)
CMU PRDA	J. Osborn (CMU)	412-268-6553	

NEEDS STATEMENT: DD-26**ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.03****Focus Area: Facility Transitioning, Decommissioning, and Final Disposition****Description of Need: Operations Surveillance System (Robotics/Automation)**

The Robotics and Automation portion of the D&D demonstrations addresses the cross-cutting technology portions that are applicable to multiple technology demonstrations. The work of this proposal would initially apply to a selected demonstration, but would be applied to other demonstrations in essentially the same configuration.

The Operations Surveillance System is a hardware and systems improvement approach to the need for quality, full-time oversight of remote operations. The latter includes protected human entry application (i.e. "plastic suit operations") and automated remote operations (i.e. robotic or tele-robotic). The technology components related to remote surveillance must address specific needs of the D&D program. The remote overview of D&D sites is crucial to the quality overview, documentation, and control of operations. The traditional approaches of direct entry of personnel to oversee operations does not adequately address the ALARA aspects of personal safety or quality of operations.

The hardware aspects of remote surveillance must address the quality, costs, and reliability aspects of remote sensors (i.e. video, audio, etc.) in a highly cluttered and contaminated environment. Currently available commercial systems are not directly applicable to such environments, due to incompatibility with remote equipment, extreme costs, or functional limitations.

R&D Objectives:

The specific need is for a systems approach to remote surveillance of remote operations. It is anticipated that this would integrate the factors listed below into a systems approach:

- Surveillance packages will incorporate video, audio, lighting, and viewing control into rugged deployment packages, sealed for decontamination. These packages will have no exposed wiring, will meet Class I, Division I electrical classification, and will be inexpensive.
- Field cabling from remote packages should utilize minimized wiring technology (i.e. multiplexing or signal combining), due to the inherent problems of tethers.
- Multiple, simultaneous remote video displays will be developed for work areas.
- A systems approach will be developed for surveillance data recording, documenting, and correlating with other information.
- Additional surveillance sensors will be provided, as applicable.

Window of Opportunity:

Uranium processing facilities at the Fernald plant involve ongoing deactivation activities. These activities can be directly and immediately improved with positive results from this concept evaluation.

Other Applicable IDs/IPs: EM-50 Robotics Technology Development Program, Underground Storage Tank Integrated Demonstration

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
LDUA - Video and Photography System	F.M. Heckendorn (SRTC)	803-725-5207	M. O'Rear (SR)

NEEDS STATEMENT: DD-27

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Materials Disposition Data Base (Systems Study)

General Need

The end of the Cold War, and the decision to reduce the size of the nuclear weapons production complex, have created a need for DOE to deactivate, decontaminate, and decommission (DD&D) a large number of facilities. The large quantities of waste that will result from DD&D will greatly add to the cost of waste disposal, and may overwhelm the solid waste operations of the DOE complex.

Specific Need

Systems studies are needed to define optimal materials disposal strategies for DD&D solid waste on a site-by-site basis. The first task will develop a database of the inventory of metals, other potentially recyclable materials, concrete, etc., that would result from DD&D across the complex.

R&D Objectives:

Define and develop a database of DD&D solid waste to support systems analyses of materials dispositions alternatives. These alternatives include the recycling of metals and alternatives to the burial of massive amounts of concrete as Radiation Adsorbed Dose (RAD) waste. Data will include, but will not be restricted to, (1) volumes/quantities; (2) physical characteristics (e.g., type of metal, other recyclable materials, concrete, etc.); (3) hazardous constituents (e.g., RCRA classification); (4) waste categories (e.g., contact-handled low-level waste class 1, remote-handled transuranic mixed waste); (5) locations (e.g., listed by DOE site, building number, etc.); (6) schedule of availability of material; and (7) data sources.

This is a two-year effort. For FY 95, define and develop the database structure to support materials disposition systems analyses and identify data sources to be used in FY 96. This effort will require input from major DOE sites and from the Metals Recycle Program. This year's products should also include plans for completing the second year effort. The plan should include cost and schedule information. For FY 96, collect, enter and verify data in the database. Products will include the database itself and appropriate support documentation.

NEEDS STATEMENT: DD-28**ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.03****Focus Area: Facility Transitioning, Decommissioning, and Final Disposition****Description of Need: Complex-Wide System Studies (System Study)****General Need**

The end of the Cold War, and the decision to reduce the size of the nuclear weapons production complex, have created a need for DOE to deactivate, decontaminate and decommission (DD&D) a large number of aging surplus facilities. Comprehensive strategic plans must be developed for facilities transition and DD&D for each major DOE site and for the integrated DOE complex, to guide in detailed planning and implementation of the DD&D Program.

Specific Need

Comprehensive strategic technical planning, including economic evaluations, is recommended as a necessary adjunct to the technology demonstrations to maximize capabilities in transitioning and D&D given limited funds. A bottoms-up approach which takes advantage of individual and corporate knowledge at the sites will be conducted under broad guiding principles approved by Headquarters.

R&D Objectives:

Teams would be formed at the following major sites: the Rocky Flats Plant, Savannah River Site, Idaho National Engineering Laboratory, the Hanford Reservation, and Oak Ridge National Laboratory to produce comprehensive, site-specific strategic plans for transition and D&D of all site facilities from their present status to their recommended end states. The teams would consist of an experienced section of personnel representing DP, EM-60, EM-50, EM-40, and EM-30. Each team would examine facility end-state options and consider the impact of new technologies and integration of inter-site and multi-site issues on risk, life cycle costs, land re-use options, regulations, and waste generation. Team efforts would be planned and coordinated by the integrating laboratory. The teams would produce an integrated complex-wide plan to explicitly show how innovative technologies will reduce the risks and costs associated with facilities transition and D&D.

A three-year maximum effort is envisioned, with the potential for continued funding. For FY 95, each designated site will organize a team and develop a plan (including cost, schedule and deliverables) to complete the task. This will involve meeting with the complex-wide facilitator and representatives from other sites to develop standard guidelines and methodologies. The resulting methodology will be verified by application to a representative facility at each site. For FY 96, representatives from each site will develop a complex-wide plan for transitioning and D&D of facilities. The effort should be leveraged to the extent possible for funds from EM-30/40 and 60. The complex-wide plan will be based on integrating site plans developed using the standard methodology. The complex-wide plan will identify transition, D&D, and waste management issues and technology needs. In FY 97, products may include further developing complex-wide plans to include stakeholder acceptance and the impacts of programmatic changes, recycle status and de minimis standards.

NEEDS STATEMENT: DD-29**ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.03****Focus Area: Facility Transitioning, Decommissioning, and Final Disposition****Description of Need: Real-Time Asbestos Characterization (Uranium - Asbestos)**

Contaminated asbestos and transite represents a significant D&D problem for most DOE sites. Cost associated with D&D and disposal of these materials is a major concern. A wide variety of contaminants are represented, including radionuclides and hazardous chemicals (both heavy metals and organics). Two representative sites with significant near-term D&D plans are Fernald (where D&D is at an advanced state of planning) and Rocky Flats (which is initiating D&D planning).

R&D Objectives:

Current baseline technology for characterization of asbestos-containing material (ACM) is physical observation, inspection for friability, manual sampling for laboratory analysis, transportation of the sample to a laboratory, verification by visual examination, and transfer of documented results back to the field sampling location. This process is labor-intensive and time-consuming, due to the suit-up and containment requirements and the logistics of physical transportation of samples and linking documented results to field locations.

The in situ, real-time characterization of insulation is needed to increase productivity and reduce labor costs associated with characterization and dismantlement operations involving asbestos. The method or analysis system must meet the following performance objectives: (1) verify the presence or absence of asbestos fibers in less than 5 minutes; (2) if invasive measures are required, the design shall preclude containment or operator respiratory protection requirements; (3) a retrievable record of the sample identification number and corresponding results shall be an integral part of the system; (4) a calibration/verification source will be supplied with the system; and (5) the system will be portable and readily handled by one person.

Development of this system is estimated to require two years. The first year is expected to be proof of principle prior to incorporating the technology into a field instrument.

Window of Opportunity:

D&D implementation at the Fernald site is already under way with CERCLA Removal Actions. Detailed D&D planning and technology treatability studies to support the CERCLA Record of Decision (ROD) (draft due in FY 97) have also commenced in the EM-40 program, providing an excellent opportunity for EM-40/50 teaming in the FY 95 through FY 99 timeframe.

Other Applicable IDs/IPs:**Currently Related Tasks: None**

NEEDS STATEMENT: DD-30**ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.03****Focus Area: Facility Transitioning, Decommissioning, and Final Disposition****Description of Need: Improved Strippable Coatings (Uranium - System)**

Contaminated equipment used to process depleted and low-enriched uranium represents a significant D&D problem for many DOE sites. Cost associated with D&D and disposal of this equipment is a major concern. A wide variety of surface and subsurface contaminants are represented, including radionuclides and hazardous chemicals (both heavy metals and organics). Two representative sites with significant near-term D&D plans are Fernald (where D&D is at an advanced state of planning) and Rocky Flats (which is initiating D&D planning).

R&D Objectives:

The uranium process systems located throughout the complex are typically large, heavy industrial-type facilities, which have accumulated significant levels of surface contamination throughout the years of operation. Innovative methods to decontaminate these large surface areas are needed. The demonstration of the use of strippable fixatives is desired to define the applicability of this technology against surface washing and other alternative decontamination methods.

Strippable coatings are an accepted procedure for decontaminating surfaces. Commercially available strippable coatings are subject to significant performance limitations. The decontamination factor achieved is generally low. There is considerable variability in the ease of removal (stripping). For applications where items are coated, dismantled and transported to a decontamination area for stripping, the available coatings have limited abrasion resistance. In field tests, improved strippable coatings will exhibit performance that overcomes the limitations cited above. For improved strippable coatings, a successful plan must address the following factors in both initial testing and field demonstration phases:

- Identify decontamination factors and limits of applicability on the following surfaces: concrete, transite, carbon steel, stainless steel, and painted surfaces, all with varying levels of surface roughness and corrosion.
- Identify various application and removal techniques for use on equipment, in accessible areas; for use in overhead areas or from platforms; for use in cracked, creviced, or gasketed areas; and for use in interior surfaces of equipment.
- Identify limitations for application techniques in dusty areas as impacts Personal Protection Equipment (PPE), and advantages in reduction of PPE use that may be derived from the use of coatings.
- Identify interactions between the use of strippable coatings and other decontamination techniques, as well as with residual oils and organics that may remain on surfaces from previous operations.

- Examine potential use of fixatives as a sampling technique to determine decontamination efficiency and needs for future additional decontamination.
- Determine compatibility with waste disposal techniques.

Deliverable: A report describing applicability of examined techniques at the various principal DOE uranium-contaminated sites. The plan will be expected to support a two-year activity

Phase 1: Test the use of fixatives in limited areas on different materials; evaluate application techniques; conduct system studies of waste disposal options, application/removal options, etc.

Phase 2: Conduct field demonstration; emphasize operational issues, cost efficiency, etc.

Window of Opportunity:

D&D implementation at the Fernald site is already under way with CERCLA Removal Actions. Detailed D&D planning and technology treatability studies to support the CERCLA ROD (draft due in FY 97) have also commenced in the EM-40 program, providing an excellent opportunity for EM-40/50 teaming in the FY 95 through FY 99 timeframe.

Other Applicable IDs/IPs:

Currently Related Tasks: None

NEEDS STATEMENT: DD-31

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Characterization and Decontamination Technologies Applicable to Mercury Contamination of Lithium Processing Equipment (Lithium)

Mercury-contaminated process equipment can be found in lithium processing facilities, primarily at the DOE Y-12 Plant. There is an estimated 7000 tons of mercury-contaminated equipment and piping at this site. The piping and process equipment diameters vary from very small to extremely large. Some process equipment contains considerable internal components. The primary focus for this activity is the development of mercury sampling and monitoring technologies and mercury decontamination technologies applicable for in situ internal equipment characterization and decontamination. If in situ internal characterization and decontamination can be successfully accomplished, the threat of environmental and/or increased facility contamination during equipment dismantlement will be greatly reduced.

Technology Needs:

Two specific technology solutions related to internal equipment mercury contamination are required.

Task 1: Technology is required for real-time, certifiable, field characterization for mercury contamination internal to the process equipment. The methods must include statistical sampling plans to ensure that the equipment is completely characterized. The methods must provide the capability for real-time mercury detection, sampling, and monitoring within the process equipment. Characterization activities will be required before, during, and after decontamination activities. The proposed R&D should thoroughly develop the characterization method concept, implement laboratory-level capability to provide sufficient test data to prove viability and effectiveness, and provide a concept for actual field deployment of the method. A one-to-two year effort is envisioned. The results of this activity will provide a decision point for a request for a prototype system for field testing.

Task 2: Technology is required for inexpensive, in situ, internal mercury decontamination for the process equipment and piping within the lithium processing facility. Successful in situ decontamination will minimize the amount of mercury that must be removed by ex situ means, such as thermal desorption. The proposed R&D should thoroughly develop the decontamination method concept, implement laboratory-level capability to provide sufficient test data to prove viability and effectiveness, and provide a concept for actual field deployment of the method. The decontamination must address the collection of the resulting mercury and minimization of mercury vapor generation and/or release.

Window of Opportunity:

This Integrated Demonstration must concur with existing and planned EM-30/40/50/60 activities applicable to this area. This capability should be available to support the onset of D&D activities at the Y-12 Plant currently scheduled to begin in FY 98.

Other Applicable IDs/IPs:**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPQ</u>
EM-40 Y-12 D&D Technical Services Activities	Y. C. Childs (ORNL)	615-576-8155	J. Moore (OR)

NEEDS STATEMENT: DD-32

ID/IP: Decontamination and Decommissioning of Facilities Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.03

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Nickel Recovery and Decontamination of Metals (Metals)

Demonstrations of decontamination and recycle technologies applicable to a wide range of scrap metals available at numerous DOE sites, which are contaminated with radiological and/or undesirable chemical species, are required to permit beneficial reuse of these metals within the DOE complex. Such scrap metals include significant quantities of mild steel, stainless steel, nickel, aluminum, lead, precious metals, and virtually any of the metals of commerce. Depending on the applications in which the metals had been used, radioactive contaminants could include U, Th₂₃₄, Pr₂₃₄, Cs₁₃₇, Tc₉₉, Pu₂₃₉, Np₂₃₇, tritium, fission products, and/or activation products. Chemical contaminants can include mercury, lithium, and numerous heavy metals.

An Integrated Demonstration was initiated in FY 94 to clean, size, remelt, and fabricate stainless steel Radioactive Scrap Metal (RSM) into 100 cubic feet boxes and/or 55-gallon drums for utilization in a controlled release environment. An additional effort for the demonstration of an integrated process for decontamination of GDP nickel has been proposed. Recommended efforts would concentrate on bench-scale demonstration of electrorefining for Tc removal. On-going EM-30 programs at INEL have been directed to establishing DOE-RSM inventories and evaluation of pyrometallurgical decontamination technologies. Future demonstration efforts will be directed to processing and recycle of other forms of contaminated metals within the DOE Complex. Metals recycle activities are directed toward establishing regional RSM recycle industries.

Technology Needs:

For FY 95, metals recycle work needs to be initiated in the following areas:

Nickel Recovery: Initiation of the GDP Nickel recovery demonstration program. Efforts in FY 95 should be directed to the demonstration of pyrometallurgical processing methods for slag/metal separation of uranium and chemically active uranium daughter products, and scale-up of electrorefining processing for Tc separation. It is estimated that demonstration efforts on nickel processing would continue in FY 96.

Decontamination of Lithium Processing Equipment (Ex Situ): Initiation of a demonstration of technologies for the removal of mercury, lithium and depleted uranium from mild steel, stainless steel and nickel components used in lithium processing operations. Removal of such contaminants must be to a level sufficient to permit recycle of the base metals for beneficial reuse within the DOE complex. The FY 95 results should include recommendations for pilot-test equipment and demonstrations to be carried out in FY 96.

Decontamination of Aluminum, Copper, Lead and Precious Metals: Initiation of three scoping studies for developing process recommendations and flow sheets for decontamination of aluminum, lead and precious metal scrap. The results of these studies should lead to recommendations for process demonstrations to be initiated in FY 96 and following.

The described activities are expected to be carried out over the next five years, with a yearly assessment to determine levels of continued funding.

Window of Opportunity:

Integrated Demonstrations must concur with existing and planned EM-30/40/50/60 activities applicable to each area. Capabilities are needed to support the onset of D&D activities, such as those at the Y-12 Plant, currently scheduled to begin in FY 98.

Other Applicable IDs/IPs:

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Stainless Steel Beneficial Reuse Program	W. L. Boettinger (SRTC)	803-725-4833	M. O'Rear (SR)
EM-40 Y-12 D&D Technical Services Activities	Y. C. Childs (ORNL)	615-576-8155	J. Moore (OR)
Advanced Technologies for Decontamination and Conversion of Scrap Metal (PRDA)	D. R. Floyd (ORNL)	615-481-8455	J. Moore (OR)
Catalytic Extraction Processing of Contaminated Scrap Metal (PRDA)	C. Nagel (MIT)	617-487-7623	D. Trader (RL)
Characterization of Radioactive Contamination Inside Pipes with the SEAMIST™ System (PRDA)	W. Lowry (SNL)	505-983-6698	P. Saxman (AL)
Recycling of Radioactive Scrap Metal	B. Frazee (INEL)	208-526-3775	T. Williams (ID)

BURIED WASTE
INTEGRATED DEMONSTRATION

2.5 Buried Waste Integrated Demonstration

The Buried Waste Problem

It is estimated that some 3.1 million cubic meters of buried waste is located throughout the Department of Energy (DOE) complex (as of 1990). This waste is predominantly located at DOE facilities at Hanford, the Savannah River Site, Idaho National Engineering Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory (X-10), and the Rocky Flats Plant. The wastes at these various sites have been buried or stored in several different types of structures, including trenches, pits, buildings, storage pads, or other specific structures. Waste disposal activities at DOE sites were conducted in accordance with applicable regulations and laws and accepted engineering practices at the time.

Approximately half of all DOE buried waste was disposed of before 1970. Disposal regulations prior to 1970 permitted the commingling of various types of waste (i.e. transuranic, low-level radioactive, hazardous). As a result, much of the buried waste throughout the DOE complex is presently believed to be contaminated with both hazardous and radioactive materials. DOE buried waste typically includes transuranic-contaminated radioactive waste (TRU), low-level radioactive waste (LLW), hazardous waste per 40 CFR 261, greater-than-class-C waste per 10 CFR 61.55 (GTCC), mixed TRU waste, and mixed LLW. Interstitial soils are also believed to be contaminated as a result of these disposal practices, and subsequent releases, thereby significantly increasing the volume of materials requiring remediation.

Typical buried waste includes such items as construction and demolition materials (i.e. lumber, concrete blocks, steel plates, etc.), laboratory equipment (i.e. hoods, desks, tubing, glassware, etc.), process equipment (i.e. heat exchanger, valves, ion exchange resins, HEPA filters, etc.), maintenance equipment (i.e. hand tools, cranes, oils and greases, etc.), and decontamination materials (i.e. paper, rags, plastic bags).

At INEL, the host location for the Buried Waste Integrated Demonstration (BWID), a variety of containers have been used for the disposal of buried waste. Containers used for the shipment of waste at the INEL have included steel drums (30-, 40-, and 55-gallon), cardboard cartons, and wooden boxes (up to 105 in. x 105 in. x 214 in.). Larger individual items were disposed of separately as loose trash. Degradation of the waste containers is believed to have resulted in contamination of the immediately surrounding soil. Estimates of contaminated soils at INEL are on the order of 8 million cubic feet. The specific geology at the INEL in which waste is buried involves approximately 10 to 30 feet of surficial sediments. Underlying the surface sediments is a layer of fractured basalt. There are two major thin sedimentary interbeds in the basalt layer, one interbed at a depth of approximately 110 ft, and another interbed at 240 ft. Data show that radioactive contaminants have migrated from the buried waste seams to the 110 ft interbed and possibly to the 240 ft interbed. Organics have been detected in groundwater beneath INEL (about 600 ft depth).

INEL buried waste characteristics are generally representative of other DOE buried-waste sites. Remediation technology demonstrations performed at the INEL should provide data useful for remedial decision-making at the INEL, as well as at other DOE buried waste sites. Significant remediation challenges are presented by buried waste, particularly the pre-1970 buried TRU-contaminated waste. DOE's Office of Environmental Restoration is committed to resolving the issues resulting from past disposal practices. DOE's Office of Technology Development supports these efforts to ensure that appropriate technological solutions are available to accomplish the selected

remediation objectives, and that technology demonstrations provide data useful for remedial decision making.

Buried Waste Integrated Demonstration Mission

The BWID supports the development and demonstration of technologies that, when integrated with baseline technologies, form a comprehensive remediation system for the effective and efficient remediation of buried waste throughout the DOE complex. The BWID is exploring four high-level systems for the remediation of buried waste. These systems are illustrated in Figure 2-1. These systems are the basis for the BWID technological needs for FY 95 and out-years. Technology demonstrations will be sponsored for these systems to obtain sufficient data to support remediation feasibility studies.

Figure 2-1. BWID Uses a Systems Approach for Technology Development.

Each system begins with site characterization and includes the following:

- retrieve/ex situ treat
- in situ treat/retrieve
- in situ treat/monitor
- contain/stabilize/monitor

Each system is comprised of multiple technology processes. Individual technology processes are integrated with surrounding processes and require specific input and output. To accomplish the overall system requirements, each process must perform to its expected level.

Technology Development Opportunities

Technology development opportunities exist within each technology process option illustrated in Figure 2-1. These needs should be viewed as technological advancements required to satisfy each process requirement and thus improve the baseline approach. Individual technology processes must be reviewed in relation to the system for which they are proposed.

Technology development may involve laboratory, bench-scale, or full-scale equipment testing and demonstrations, but the primary emphasis is field deployable technologies. BWID utilizes a simulated waste pit located adjacent to INEL's Subsurface Disposal Area to test and evaluate technologies. The Cold Test Pit is 40 feet wide, 150 feet long, and 10 feet deep. The original pit contained 5 cells, each representing a different waste configuration (random dumped drums, random dumped drums and boxes, stacked drums, stacked boxes, and large objects). Three new cells were recently added to support BWID characterization and retrieval demonstrations. These cells provide known targets and waste forms to evaluate technologies. Rare earth tracers have been added to the cells to evaluate contamination control aspects of tested technologies.

All proposed technology development and demonstration should be designed to address the unresolved technical issues facing the proposed technology. Therefore, the size of the demonstration equipment, the proposed experimental design, and the performance goals should be appropriate to resolve the technical issues. Proposed technologies that involve participants and technology sponsors from throughout the DOE complex, private industry, and universities will rank favorably. Collaboration with other OTD-sponsored Integrated Demonstrations and Integrated Programs is encouraged. This collaborative effort has been implemented to reduce duplication of effort, accelerate technology development, and leverage DOE funding.

Technologies potentially viable for BWID-sponsorship will be reviewed on their appropriateness to the identified needs, their integration into the defined systems, their collaboration with the private sector, and their schedule for field demonstration. Technical evaluations will utilize specific BWID performance indicators to estimate a proposed technology's effectiveness, implementability, life-cycle cost, and other data requirements.

Points of Contact:

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NEEDS STATEMENT: BW-1

ID/IP: Buried Waste Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.01

Focus Area:

Description of Need: Site and Waste Characterization

BWID will support near-field and ground-based characterization techniques that are critical to identifying and supporting the remediation processes for buried waste applications. Other Integrated Programs and Integrated Demonstrations will support other characterization techniques.

Non-Intrusive Site Characterization

BWID Technical Contacts: Dick Callow (208) 526-2042
 John Richardson (208) 525-0631

The objective of this effort is to provide logistical, physical, chemical and radiological information via non-intrusive characterization techniques. This information will support the planning and execution of future remedial action. Advanced non-intrusive technologies are needed to:

- locate the vertical pit and trench boundaries within + 2 ft.
- identify pre-retrieval characteristics, from ground surface or digface of waste types or forms and distributions (i.e. shape, size, composition, and orientation).
- conduct surface assessment of radiological, chemical, biological or other critical risk assessment source terms (hot spots).
- determine the depth to bedrock underlying waste pits and trenches within + 2 ft.
- determine the depth of the overburden/waste interface within + 20%.
- locate the position of large buried objects within + 2 ft.
- characterize regional geology and hydrogeology.
- determine soil/waste heterogeneity, integrity, and voids.
- recognize boundaries between clean and contaminated materials and soils.

Intrusive Site Characterization

BWID Technical Contacts: Dick Callow (208) 526-2042
John Richardson (208) 525-0631

This effort provides logistical, physical, chemical, and radiological information via intrusive characterization techniques. The information will support the planning and execution of future remedial action. Advanced technologies are needed to:

- identify waste types, forms and distributions from borehole to digface.
- provide a detailed subsurface planar image of buried waste.
- provide a three-dimensional map of buried waste.
- determine the depth to bedrock underlying waste pits and trenches within + 1/2 ft.
- determine the depth of the overburden/waste interface within + 20%.
- locate radiological, chemical, biological or other critical risk assessment source terms (hot spots).
- locate the position of large buried objects within + 1/2 ft.
- recognize boundaries between clean and contaminated materials and soils.

Non-Destructive Waste Assay and Characterization

BWID Technical Contact: Tim Roney (208) 526-9712

This effort should categorize waste that has been exhumed in intact containers; retrieved, loose waste/soil; retrieved, loose waste/soil that has been contained for transport; or waste/soil that has undergone some form of treatment. Key waste assay technology attributes include high throughput and low-cost methods to support waste segregation, per DOE, DOT, and EPA waste characterization specifications. Advanced technologies are needed to:

- quantify transuranic radionuclides (i.e. plutonium, americium, etc.) - < 10 nCi/g and > 100 nCi/g, and other radionuclides (cesium, strontium, etc.).
- rapidly identify and quantify transuranic and other radioisotopes for excavated waste soil, rock, and debris.
- quantify hazardous constituents (i.e. oils, asbestos gasoline).
- identify pyrophorics (i.e. gasoline, kerosene).
- identify compressed gases.
- identify and quantify free liquids (i.e. acids, oils, water).

- identify and quantify volatile organic compounds (i.e. trichloroethane, carbon tetrachloride).
- develop real-time transuranic monitoring techniques for both airborne and loose surface contamination (< 10 pCi/g and > 100 pCi/g).
- develop real-time hazardous waste monitoring techniques.
- determine bulk chemical composition (pretreatment feedstream characterization).
- develop real-time digital processing techniques for data integration/reduction.

Window of Opportunity: Site characterization activities are on-going at many buried waste sites. These activities will continue during Remedial Investigation phases. Opportunities exist now and in the near-term (FY 95/96) for implementing technology improvements to existing site and waste characterization technology.

Other Applicable IDs/IPs: Characterization, Monitoring, and Sensor Technology Integrated Program, Uranium Soils Integrated Demonstration, Mixed Waste Landfill Integrated Demonstration, Deactivation and Decommissioning Integrated Demonstration

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
<i>Site Characterization:</i>			
High-Resolution Holographic Imaging of GPR	D. Collins (PNL)	509-375-2726	D. Trader (RL)
Non-Intrusive Site Characterization	M. Donaldson (INEL)	208-526-6171	T. Williams (ID)
Field Demonstration of Characterization Technologies	B. Johnson	801-583-2697	T. Williams (ID)
Non-Intrusive Sensing of Environmentally Important Objects	C. Schwenk (GJPO)	303-248-6116	P. Saxman (AL)
Gravity Field Measurements	A. Edwards (INEL)	208-526-8358	T. Williams (ID)
Dig Face Characterization	N. Josten (INEL)	208-526-7691	T. Williams (ID)
Imaging Infrared Interferometer for VOC Characterization	G. Moore (INEL)	208-526-4847	T. Williams (ID)

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Very-Early Time-Domain Electromagnetic Sensing of Shallow Buried Waste	C. Pfeiffer (INEL) L. Pellerin (GJPO)	208-526-1893 303-236-1315	T. Williams (ID) T. Williams (ID)
Virtual Environment Generation of Buried Waste Sites	T. Larson (INEL)	208-526-5579	T. Williams (ID)
Geophysics Sensor Deployment Platforms Evaluation	C. Pfeiffer (INEL)	208-526-1893	T. Williams (ID)
<i>Waste Assay/Characterization:</i>			
Combined Thermal/ Epithermal Neutron (CTEN) Interrogation of TRU Waste	K. Koop (LANL)	505-667-5372	P. Saxman (AL)
Radioactive and Hazardous Material Measurement System	T. Roney (INEL)	208-526-9712	T. Williams (ID)
NDA Characterization of Containerized TRU/LLW Waste (Computed Tomography)	H. Martz (LLNL)	510-423-4269	R. Scott (SF)
Assay of Excavated Soils and Debris	T. Roney (INEL)	208-526-9712	T. Williams (ID)
High-Speed Digital Radiography	T. Roney (INEL)	208-526-9712	T. Williams (ID)
Field Deployment of Mobile Rapid Transuranic Monitoring Laboratory	C. McIsaac (INEL)	208-526-0581	T. Williams (ID)
Real-time Monitoring of TRU-contaminated Dust	J. Finke (INEL)	208-526-2031	T. Williams (ID)
Electrothermal Hollow Cathode	S. Weeks (AMES)	515-294-4922	S. Webster (CH)

NEEDS STATEMENT: BW-2

ID/IP: Buried Waste Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.01

Focus Area:

Description of Need: Retrieval of Untreated Waste

BWID Technical Contact: Brad Griebenow (208) 526-0501

In FY 95, previously developed technologies will be integrated with newly identified technologies into a full-scale retrieval system for demonstration at the INEL Cold Test Pit. This full-scale retrieval system demonstration will include site characterization, retrieval, treatment and assaying technology. The retrieval portion will include two scenarios currently identified by the Office of Environmental Restoration as potential remedial alternatives: hot spot and full-scale retrieval. Hot spot retrieval consists of retrieving a selected portion of a buried waste site in conjunction with an overall waste containment/stabilization remedy. Full-scale retrieval includes the complete excavation and conveyance of waste from a buried waste site for treatment and disposal. The FY 95 retrieval system demonstration will be conducted at a simulated buried waste pit at the INEL (Cold Test Pit). Individual technology demonstrations will need to evaluate technology potential to minimize secondary waste generation, costs, and personnel exposure.

The primary retrieval technology needs are presently under development, including remote excavation, contamination control, and waste conveyance systems. In FY 95, emphasis will be placed on technologies supporting the integrated retrieval system demonstration at the INEL Cold Test Pit. Key technology gaps include movable containment structure and visual simulation, and control systems for an unstructured retrieval environment to oversee the actions of the individual subsystems.

Hot spot retrieval technology needs include:

- remote delivery system to move retrieval and support equipment to the hot spot location.
- movable containment structures in which operations will be performed.
- contamination control.
- waste form removal.
- pit stabilization.
- methods to remotely exhume waste areas of varying size.

Primary full-scale retrieval technology needs include:

- innovative remote exhumation techniques to support 80 cubic yards/8 hr shift retrieval rate minimum.

- contamination control techniques to maintain airborne contaminant levels below 10,000 X maximum permissible concentration in air.
- dust-free methods for placing exhumed waste into containers for subsequent conveyance (98% dust removal efficiency for dry soil).
- conveyance systems to move waste from digface to processing area.
- innovative containment structures in which operations will be performed and that can be mobilized from pit to pit as remediation is completed.
- automated data tracking system to record retrieved waste source location and transportation/conveyance status.
- visual simulation/sensing capability to monitor and control operations status and equipment location for collision avoidance and enhanced safety and production.

Other full-scale retrieval technology needs include:

- systems to size-reduce objects (e.g. tanks, lathes, etc.) encountered at the digface for subsequent conveyance and processing.
- system health monitoring techniques to predict component failures prior to occurrence to allow timely and cost-effective maintenance.

Window of Opportunity: Retrieval is being considered as a potential remedial alternative for selected buried waste sites at INEL, Hanford, Savannah River, ORNL, and other DOE facilities. Primary opportunity for implementation planning of innovative technology begins in the feasibility study phase of the cleanup assessment. Feasibility studies are now on-going at some sites, with others planning for feasibility studies in FY 95 and 96.

Other Applicable IDs/IPs: Robotics Program, Uranium in Soils Integrated Demonstration, Deactivation and Decommissioning Integrated Demonstration, Underground Storage Tanks Integrated Demonstration

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Automated Waste Conveyance of Retrieved Waste	P. Rice (INEL)	208-526-2884	T. Williams (ID)
ER/OTD Remote Excavation Demonstration at ORNL	B. Burks (ORNL)	615-576-7350	J. Moore (OR)
Innovative End Effector to Minimize Dust	P. Rice (INEL)	208-526-2884	T. Williams (ID)

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Contaminated Material Excavation/Handling/ Containment Concept	G. Carter (PNL)	509-372-0607	D. Trader (RL)
Full-Scale Telerobotic Retrieval Demonstration	J. Rawlins (INEL)	208-526-4304	T. Williams (ID)
Cryogenic Cutting System	D. Bingham (INEL)	208-526-1376	T. Williams (ID)
Cooperative Telerobotic Retrieval	K. Croft (INEL)	208-526-8276	T. Williams (ID)
System Health Monitoring	R. MacDonald (INEL)	208-526-5071	T. Williams (ID)

NEEDS STATEMENT: BW-3**ID/IP: Buried Waste Integrated Demonstration****Work Breakdown Structure Number: 01.05.01.02.01****Focus Area:****Description of Need: Ex Situ Treatment****BWID Technical Contact: Steve Bates (208) 526-6790**

This effort performs demonstrations on various inter-related waste pre-treatment technologies, primary treatment technologies, and associated secondary systems (i.e off-gas systems) for the immobilization, detoxification, volume reduction, and/or stabilization of waste components. These demonstrations should provide sufficient information on technologies to support the ER Remedial Investigation/ Feasibility Study (RI/FS) process. Three interrelated areas, pretreatment, primary treatment, and secondary treatment, should be addressed from a systems viewpoint for the demonstration and evaluation of technologies for this effort. System recycling should be considered, as well as secondary waste stream treatment.

In FY 95 and out-years, the BWID program will focus on-going treatment technology development activity, and initiate radioactive testing in those areas. Radioactive testing on bench- and pilot-scale technology will facilitate ER decision-making through the RI/FS process.

Pretreatment

Pretreatment of various retrieved waste streams may be required (depending on the primary treatment technology) to minimize the amount of waste to be treated or to optimize the primary treatment of the waste. A throughput goal of 1-14 tons/hr is desirable for these technologies. Advanced technologies are needed for the pretreatment of retrieved buried waste and contaminated interstitial soils. These technologies must be capable of:

- advanced sorting of retrieved waste into waste types (soils, metals, combustibles, TRU, LLW, hazardous, etc.).
- assaying organics, hazardous, elemental, and radioactive constituents using continuous or semi-continuous (batch) processes. This assay will be for large bulk volumes of waste on a real-time or short-time basis.
- size reduction/volume reduction (i.e. shred, compact, cryofracture incineration of combustibles, etc.).
- pre-processing retrieved waste to optimize treatments.

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Primary Treatment Technologies

Treatment of the waste will include processing solid, mixed, hazardous, and radioactive waste associated with combustibles, metals, soil, and sludges and their associated structures (i.e. drums, boxes, large metal objects, etc.). Treatment may be conducted using thermal, chemical, biological, physical, and/or radiological methods for all or part of the waste streams. A "robust" primary treatment system developed to minimize characterization and pretreatment is desirable. The processing limitations (i.e. reliability in operation, maintenance, non-processable components, system lifetime, feed size, heterogeneous feed compositions, etc.) of the technologies should be determined. Emphasis should be given to the volume reduction of the waste and the minimization/treatment of secondary waste streams. This would also include the separation of delisted/recyclable portions of the waste. The development of enhanced waste forms from the waste should also be evaluated. Final waste forms must meet minimum waste acceptance criteria, including TCLP and other criteria that are currently being established.

These technologies must be able to:

- treat a significant portion of contaminants retrieved from the waste stream.
- minimize the amount of untreated waste.
- contain all contamination during treatment.
- process any off-gases.
- minimize the generation of secondary waste.
- be verified.

Secondary Treatment Technologies

Pre-treatment and primary treatment technologies may require additional secondary systems. Some of these systems will be integral parts of the technologies, but may be improved by new technologies. Advanced technologies are needed, such as:

- Feed systems - including the delivery of waste streams in their associated structures to the treatment system. The reliability in remote operation and process control must be optimized.
- Off-gas systems - Various types of off-gas systems needed depend on the type of treatment technology. The primary need lies in the treatment of off-gas for high-temperature thermal treatments. The off-gas systems must remove regulated and radioactive components from the off-gas while minimizing secondary waste streams. Closed off-gas systems will be given a high priority.
- Secondary waste stream treatment - The potential for various secondary waste streams exists, which adds to the final disposal cost. Any methods to detoxify, reduce, or treat secondary waste streams may be considered.

- Final waste form verification - As the waste form is produced, the product quality of the waste form must be verified prior to disposal. Extensive sampling is not desirable due to the high analytical cost. NDA/NDE methods to verify final waste form quality on a real-time or short-time basis is needed.

Window of Opportunity: Retrieval followed by ex situ treatment is being considered as a potential remedial alternative for selected buried waste sites at INEL, Hanford, Savannah River, ORNL and other DOE facilities. Primary opportunity for implementation planning of innovative technology begins in the feasibility study phase of the cleanup assessment. Feasibility studies are now on-going at some sites, with others planning for feasibility studies in FY 95 and 96.

Other Applicable IDs/IPs: Uranium in Soils Integrated Demonstration, Mixed Waste Integrated Program, In Situ Remediation Integrated Program, Supercritical Water Oxidation Program

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Arc Melter Vitrification	N. Soelberg (INEL)	208-526-6923	T. Williams (ID)
STRATEX for Soils Treatment	B. Peters (ANL)	708-252-7773	S. Webster (CH)
Graphite DC Plasma Arc Furnace	J. Surma (PNL)	509-376-4905	D. Trader (RL)
Non-Thermal Plasma Secondary Off-Gas Treatment	L. Rosocha (LANL)	505-667-8493	P. Saxman (AL)
Modeling of Thermal Plasma Arc Technology	M. McKellar (INEL)	208-526-1346	T. Williams (ID)

NEEDS STATEMENT: BW-4

ID/IP: Buried Waste Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.01

Focus Area:

Description of Need: In Situ Treatment

BWID Technical Contact: Steve Bates (208) 526-6790

In situ treatment of buried waste can serve two separate objectives, depending on the selected remediation concept: (1) in situ treatment with long-term monitoring for in-place disposal; and (2) in situ treatment prior to retrieval of the treated waste form, and, ultimately, disposal at an appropriate facility.

In Situ Treatment/Long-term Monitoring

The objective of this effort is to perform demonstrations of in situ treatment, in which the processed buried waste is to be left in place. The performance characteristics of the treated waste must provide suitable containment or destruction of both hazardous and radiological waste constituents in both the wastes and interstitial soils. This treatment must represent a "permanent" solution, in which long-term contaminant release to groundwater, surface soils, or air is reduced to acceptable levels. Advanced technologies are needed for the in situ treatment of buried waste and contaminated interstitial soils for in-place disposal. These technologies must:

- treat all contaminants within the waste stream to provide long-term containment of residual contaminants.
- treat to depths from 15 to 25 feet.
- minimize the amount of untreated wastes.
- contain contaminants during treatment to below regulatory levels.
- treat process off-gases to below regulatory levels.
- minimize generation of secondary wastes.
- be verifiable.

In Situ Treatment/Retrieval

For this concept, the primary purpose of the in situ treatment is to minimize the potential spread of contamination during the retrieval process. This combination of in situ treatment followed by retrieval must provide a significant advantage in contamination control over the retrieval of untreated wastes. Advanced technologies are needed for the in situ treatment of waste and contaminated interstitial soils. These technologies must:

- produce a retrieval product using conventional retrieval technology.
- treat to depths from 15 to 25 feet.
- minimize the amount of untreated wastes.
- contain contaminants during treatment to below regulatory levels.
- treat process off-gases to below regulatory levels.
- minimize generation of secondary wastes.
- be verifiable.

Window of Opportunity: Primary opportunity for implementation planning of innovative technology begins in the feasibility study phase of the cleanup assessment. Feasibility studies are now on-going at some sites, with others planned for FY 95 and 96.

Other Applicable IDs/IPs: Mixed Waste Landfill Integrated Demonstration, In Situ Remediation Integrated Program

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Innovative Grout	G. Loomis (INEL)	208-526-9208	T. Williams (ID)

NEEDS STATEMENT: BW-5

ID/IP: Buried Waste Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.01

Focus Area:

Description of Need: Containment/Stabilization/Long-Term Monitoring

BWID Technical Contact: Guy Loomis (208) 526-9208

Technologies are needed to stabilize and contain radionuclide and hazardous buried waste contaminants. The objective of these technologies is to reduce and/or eliminate the potential for contaminants to migrate from the buried waste matrix. At the INEL Subsurface Disposal Area, the primary release mechanism for buried waste contaminants is leaching from the waste matrix through soils and fractured basalt to groundwater. Secondary release mechanisms include airborne dispersal at the ground surface and vegetative uptakes.

BWID technology needs focus on containing and stabilizing contaminants within the buried waste streams. Other Integrated Demonstrations and Integrated Programs are pursuing technologies to contain and remediate contaminant plumes that have migrated from the source.

Stabilization and containment technologies must:

- demonstrate an effective reduction or elimination of contaminant releases through surface dispersal and/or leaching.
- reliably deliver, mix and disperse stabilization agents (grouts, etc.), including delivery of grout, into the waste matrix with sufficient energy to rupture containers and mix with waste forms.
- serve as a barrier for inhibiting contaminant migration and be resistant to waste contaminants and potential subsidence.
- not preclude subsequent treatment or waste retrieval.
- be verifiable to ensure the buried waste of concern is adequately stabilized and contained.
- minimize generation of secondary waste (e.g., during capping, jet grouting, and well plugging).

In order for containment and stabilization technologies to be considered a long-term remedy for buried waste, adequate capability to predict and monitor performance of the contained buried waste is necessary. Therefore, technology is needed to:

- provide long-term monitoring of contained and/or stabilized buried waste contaminants through innovative intrusive and/or non-intrusive techniques.

- verify that the buried waste source term of concern is adequately stabilized and contained.
- improve predictive capabilities to evaluate long-term performance of various containment and stabilization technologies for multiple waste types; includes increased understanding of the grout/waste chemistry, long-term grout stability in the presence of wastes and surface and groundwater, sensitivity of grout performance, and development of new grouting agents

Window of Opportunity: The BWID intends to conduct individual technology performance tests in FY 94 and FY 95. These technologies will support an integrated demonstration to evaluate a complete containment and stabilization system for a simulated buried waste site beginning in FY 96. This demonstration will evaluate both surface containment (capping) and subsurface stabilization/containment technologies, as well as long-term monitoring technology.

Other Applicable IDs/IPs: In Situ Remediation Integrated Program, Mixed Waste Landfill Integrated Demonstration

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Monolithic Confinement of Fractured Basalt	J. Alexander (PNL)	509-372-2112	D. Trader (RL)
In Situ Encapsulation of Buried Waste	J. Weidner (INEL)	208-525-5834	T. Williams (ID)

NEEDS STATEMENT: BW-6

ID/IP: Buried Waste Integrated Demonstration

Work Breakdown Structure Number: 01.05.01.02.01

Focus Area:

Description of Need: Disposal and/or Interim Storage

BWID Technical Contact: Guy Loomis (208) 526-9208

Following retrieval and treatment of buried wastes, the resulting waste forms will be packaged for either interim storage followed by disposal, or immediate disposal. Interim storage durations may range from several days to years, pending the availability of a disposal facility. The waste form packaging (drums, large boxes, etc.) and type (vitreous, grouted, untreated) may also vary, depending on the selected retrieval and treatment technologies. Prior to interim storage or disposal, waste forms must be characterized to ensure that disposal and storage regulations and acceptance criteria are met.

Currently, no disposal site exists for buried transuranic-contaminated wastes. The DOE Waste Isolation Pilot Plant (WIPP) is presently undergoing testing and evaluation. The BWID seeks innovative disposal alternatives for transuranic-contaminated retrieved buried waste. Primary technology needs include:

- investigate innovative disposal concepts for transuranic-contaminated buried wastes, including reclassified TRU waste (e.g. TRU transmutation to short-lived or stable isotopes).
- develop proposed specific waste acceptance criteria to define buried waste treatment and packaging requirements.
- develop technologies that minimize the volume of waste requiring disposal (waste segregation, treatment, packaging, certification - see other need descriptions).

Window of Opportunity: Disposal and interim storage decisions for retrieved buried waste will be documented in the Record of Decision for each buried waste retrieval site. Availability of interim storage/disposal facilities and their acceptance criteria will drive many aspects of the retrieval and treatment alternative. Therefore, innovative alternatives to the present technology baseline are needed during the feasibility study phase of the site assessment. Feasibility studies are either on-going or in the planning stages for most sites. FY 95 through FY 97 is the present window of opportunity for development of alternative disposal and interim storage concepts.

Other Applicable IDs/IPs: None

Currently Related Tasks: None

SECTION 3.0
INTEGRATED PROGRAMS

CHARACTERIZATION, MONITORING

&

SENSOR TECHNOLOGY

INTEGRATED PROGRAM

3.1 Characterization, Monitoring and Sensor Technology Integrated Program (CMST-IP)

The CMST-IP delivers needed characterization, monitoring, and sensor technology to its customers (EM/30/40/60) when required. For FY 95, these needs are grouped into the following focus areas:

- Expedited site characterization.
- Characterization and monitoring of high-level waste tanks.
- Characterization and monitoring of mixed waste, waste processes, and effluents.
- Characterization support for decontamination and decommissioning activities.
- Sensor development in collaboration with the robotics program.
- Sensor and field analysis equipment.
- Characterization decision support tools.
- Geophysical and hydrogeologic measurements.

Some of the needs listed above are being addressed in currently funded projects. Therefore, a list of related FY 94 projects has been provided within each needs statement, in order to avoid proposals that duplicate on-going work.

For proposed technology development, parameters/constituents of interest must be specified with corresponding performance goals, including limits of detection, accuracy, and precision. Baseline techniques (if they exist) must be identified with lists of performance specifications, so that figures of merit the proposed technology can be compared. In addition, performance goals must be consistent with the functional and operating requirements established by the customer(s). TTPs must identify specific customers. Evidence of communication with the prospective customers must be demonstrated in TTPs.

It is also preferred that TTPs contain evidence of planned collaboration with EM-30/40/60 customers, private industry, universities, or other government laboratories. The collaboration shall be aimed at leveraging human and financial resources, and at facilitating the implementation and commercialization of the proposed technology development. The importance of collaboration will be reflected in the funding decisions.

Refer to the Technology Needs Crosswalk Report (RUST Geotech Inc., January 1993, DOE/ID/12584-117 Ed. 1), which provides details on site-specific needs. The same report also gives those new in the field the names of DOE site contacts who have more detailed information about needed technologies that may lead to collaborative efforts.

Questions concerning the CMST-IP FY 95 needs should be directed to:

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NEEDS STATEMENT: CM-1

ID/IP: Characterization, Monitoring and Sensor Technology Integrated Program

Work Breakdown Structure Number: 01.05.01.01.08

Focus Area: Contaminant Plume Containment and Remediation; Landfill Stabilization

Description of Need: Expedited Site Characterization

Expedited Site Characterization (ESC) will decrease characterization costs, save time, be less intrusive, and achieve regulatory acceptance. Basic features of the ESC methodology include:

- comprehensive research and planning before field work begins.
- use of minimally intrusive and field deployable techniques (an example of a minimally intrusive technique is the use of the cone penetrometer to deploy or emplace both sensors and sampling probes for rapid determination of contaminants, hydrogeologic properties, and/or subsurface soil properties).
- sound judgments based on rapid integration and analysis of data in the field.
- a dedicated technical team with diverse expertise and strong field experience to participate in decision-making from initial planning, through field program/implementation, to final reporting.

The success of implementing ESC methodology to reduce site characterization time and cost has been demonstrated at various sites. Results are well documented (Burton 1992; Burton, et al. 1993). Wide-scale implementation of this methodology is necessary to ensure timely delivery of site data for input to Records of Decision. Many DOE sites are contaminated with volatile organic compounds (VOCs), heavy metals, inorganic anions, radionuclides, and combinations of the above. Proposals are sought to implement ESC methodology at DOE sites.

Window of Opportunity: Present - FY 96

Other Applicable IDs/IPs: VOC-Arid ID, MWLID

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Expedited Site Characterization, Application to Federal Facilities	J.C. Burton (ANL)	708-252-8795	S. Webster (CH)
Ames Expedited Site	A. Bevolo (AMES)	515-294-6406	S. Webster (CH)

References:

Burton, J.C., "Prioritization to Limit Sampling and Drilling in Site Investigation," in *Proceedings of Federal Environmental Restoration Conference and Exhibition*, pp. 242-251, Vienna, VA. April 15-17, 1992. (NTIS Order No. DE922010513).

Burton, J.C., et al, "Expedited Site Characterization: A Rapid, Cost Effective Process for Preremedial Site Characterization," *Submitted to the Fourteenth Superfund Conference, Washington D.C., November 29-December 2, 1993.*

NEEDS STATEMENT: CM-2

ID/IP: Characterization, Monitoring, and Sensor Technology Integrated Program

Work Breakdown Structure Number: 01.05.01.01.08

Focus Area: High-Level Waste Tank Remediation; Mixed Waste Characterization, Treatment, and Disposal; Facility Transitioning, Decommissioning and Final Disposition; Contaminant Plume Containment and Remediation, Robotics

Description of Need: Characterization and Monitoring of High-Level Waste Tanks

Approximately 200 large underground storage tanks (USTs) have been used to capture, process, and store radioactive waste from weapons material production processes. These tanks contain highly radioactive sludges, saltcake, and supernatant liquids. The major chemical constituents are nitrate and nitrite salts, hydrated metal oxides, phosphate precipitates, transuranics, and isotopes of strontium, iodine, cesium, and technetium. The environment within the tanks is highly radioactive, i.e., 100s to 1000 Rad/h⁻, caustic, and chemically harsh (Hanlon 1993).

The objectives of this effort are to provide characterization/monitoring technology to help resolve or mitigate the waste tank safety issues, including tank leak monitoring, and to support activities required for the retrieval, pretreatment, and processing of waste in single-shell tanks.

Technology development needs include:

- in situ measurement of fissiles (Pu, Am), moisture, thermal properties, fission products (Sr, Cs), rheological and other physical properties, and head space gases (hydrogen, nitrous oxide, ammonia).
- large-area imaging techniques to identify hot spots, significant variations in layering, overall stratigraphy, buried objects, etc.
- new waste sampling methods to obtain a representative portion of the solid, sludge, slurry, liquid, crust, and/or vapor for analysis. Of special interest are the following: sludge sampler with retention of dissolved gases; large-volume (25 liter) liquid sampler; off-axis sampler to locations away from riser; and tank bottom sampler.
- screening methods to improve throughput of tank waste analysis in the hot cells.

Window of Opportunity: present - FY 2000

Other Applicable IDs/IPs: USTID; RTDP, MWLID, D&D

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Imaging through Obscuration for Sluicing	T. Peters (PNL)	509-375-2101	D. Trader (RL)
TRU and Moisture Measurement in HLW Tanks by Neutron Activation	R. Brodzinski (PNL)	509-376-3529	D. Trader (RL)
Electromagnetic Moisture Measurement in Single- Shell Tank Waste	R. Hockey (PNL)	509-375-2813	D. Trader (RL)
In Tank Interface Detection Using Time Domain Reflectrometry	H. Tilley (SRTC)	803-725-1876	M. O'Rear (SR)
Acoustic Characteri- zation in Stabilized USTs	D. Martin (AMES)	515-294-3344	S. Webster (CH)
Sensing of Head Space Gases & Continuous In Situ Monitoring	G. Bastiaans (AMES)	515-294-3298	S. Webster (CH)
Laser Ablation Mass Spectrometry Scanning of Waste Tank Core Samples	S. Colson (PNL)	509-375-6882	D. Trader (RL)
Cone Penetrometer for In Situ Waste Tank Characterization	L. Bunes (PNL)	509-376-9942	D. Trader (RL)
Effects of Gamma Irradiation on a Fiber Optic-Based Raman Probe	R. Donohoe (LANL)	505-665-6794	P. Saxman (AL)
Problem Directed Rapid Chemical Characterization	R. Jenkins (ORNL)	615-576-8594	J. Moore (OR)

Reference:

Hanlon, B.M., *Tank Farm Surveillance and Waste Status Summary Report for June 1993*. WHC-EP-0182-63.

NEEDS STATEMENT: CM-3

ID/IP: Characterization, Monitoring and Sensor Technology Integrated Program

Work Breakdown Structure Number: 01.05.01.01.08

Focus Area: High-Level Waste Tank Remediation; Mixed Waste Characterization, Treatment, and Disposal; Facility Transitioning, Decommissioning and Final Disposition; Contaminant Plume Containment and Remediation, Landfill Containment

Description of Need: Characterization and Monitoring of Mixed Waste, Waste Processes and Effluents

This section describes technology development needs in waste stream diagnostics and controls for processing of high-level, transuranic (TRU) and mixed low-level wastes. The objectives of this effort are to provide characterizing technologies for segregating and routing incoming waste streams into appropriate treatment processes; to provide effluent monitoring for optimizing treatment operation, and for ensuring compliance with safety and applicable environmental requirements; and to assure stability and integrity of final waste forms.

Specifically, these needs are grouped into the following areas:

Initial Waste Stream Characterization:

- Techniques that determine whether the waste is low-level waste, which is below 100 nCi/gram, or TRU waste.
- Reliable TRU assay in the presence of high gamma dose rates.
- Real-time measurements for lead, mercury, nitrates and organic content in waste materials.
- Measurement techniques for assessment of mixed fission products and mixed activation products in low-level waste.

Waste Process and Effluent Monitoring:

- Real-time monitoring for the detection of radionuclides, RCRA-listed heavy metals, organics, and chlorine in thermal treatment off-gas to the level below regulatory concern.
- Techniques that provide the capability of real-time/continuous measurements of radionuclides, pH, total organic carbon, reactive compounds, particulates, RCRA-listed heavy metals, tritium, and chelating agents at various measurement points as well as in aqueous and organic waste tanks.

Window of Opportunity: Present - FY 2000

Other Applicable IDs/IPs: MWIP, MWLID, BWID, USTID, D&D

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Continuous Emission Monitoring of Incinerators	J. Demirgian (ANL)	708-252-6807	S. Webster (CH)
Infrared Analysis of Wastes (FTIR-PAS & TIRS)	J. McClelland (AMES)	515-295-7948	S. Webster (CH)
Associated Particle Imaging	P. Hurley (EG&G-STL)	805-681-2472	K. McWilliam (NV)
Technical and Program Support	E. Stallings (LANL)	505-667-2236	P. Saxman (AL)

NEEDS STATEMENT: CM-4

ID/IP: Characterization, Monitoring and Sensor Technology Integrated Program

Work Breakdown Structure Number: 01.05.01.01.08

Focus Area: Facility Transitioning, Decommissioning and Final Disposition; Mixed Waste Characterization, Treatment, and Disposal; Robotics

Description of Need: Characterization Support for D&D Activities

The following are characterization, monitoring, and sensor technology needs in support of D&D activities:

- Characterize a wide variety of materials (e.g. concrete, metal equipment, internal surfaces, reactor vessel components, fuel storage sludge) to support D&D operations. Three sampling systems are needed to remove concrete core samples from floors and walls to remove sludge sample cores from the bottom of fuel storage pools, and to collect samples from the inside walls of reactor vessels. Each system must address health and safety, containment, and radiological concerns pertinent to the specific deployment.
- Design sampling systems that will not contaminate the sample with tool material. The objective is to maintain sample integrity, the sampling tool should be easily decontaminated, the system should be modular and adapt to a variety of sampling scenarios, and the system should be adaptable for remote (automated) application.
- Develop a real-time alpha sensor suitable for use under a wide range of solution conditions and activity levels to support D&D activities. The sensor should be useful from the Ci/L level (flush solutions) to the $\mu\text{Ci/L}$ level (final decontamination conditions). This sensor will be used for the analysis of decontamination and flush solutions, will help resolve criticality issues, and will provide information to evaluate the effectiveness of decontamination operations.
- Sensors are needed to determine, in realtime, RCRA-listed and other hazardous organics, including PCBs, on complex process equipment (metal) surfaces and facility structure (metal, concrete, transite, etc.) surfaces. It would be most useful to develop instrumentation that is portable (for in situ measurements), that can discriminate between organic compounds, and operate in harsh environments. The instrumentation should be amenable to facility mapping through either large surface area coverage or deployment by autonomous robotic devices. Instrument sensitivity at or below regulatory limits is useful, but the emphasis should be on ease of use, reliability, and ruggedness. The portion of the equipment placed within a contaminated environment must be capable of being decontaminated for reuse, or have low cost, easily disposable components.
- In situ, real-time trace inorganic measurement systems for continuous measurements of NPDES species, such as iron, copper, and selected anions, such as chloride and

fluoride. Sensitivity levels should meet or exceed those from current baseline instrumentation.

Window of Opportunity: Present - FY 99

Other Applicable IDs/IPs: D&D ID, RTDP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Remote Sensing Systems Development	L. R. Tinney (RSL)	702-295-8098	K. McWilliams (NV)
Multi-Analyte, Single Fiber Optical Sensor	F. Milanovich (LLNL)	510-422-6838	R. Scott (SF)
Portable Acoustic Wave Sensor Down Hole Monitoring	G. Frye (ANL)	505-844-0787	P. Saxman (AL)
Chlorinated and Aromatic Hydrocarbon Thin Film Sensors	B. Swanson (LANL)	505-667-5814	P. Saxman (AL)
Direct Sampling Ion Trap Spec. Instrumentation	M. Wise (ORNL)	615-574-4862	J. Moore (OR)
SIMS Analysis: Development and Evaluation	J. Delmore (INEL)	208-526-2820	T. Williams (ID)
RCRA Metals Analysis by Laser Induced Breakdown Spectrometry	A. Koskelo (LANL)	505-665-4463	P. Saxman (AL)
LA-ICP-AES Using a High Resolution Fiber Optic Interferometer	A. D'Silva (AMES)	515-294-9317	S. Webster (CH)
Improvements in ICP-MS	R. Houk (AMES)	515-294-9462	S. Webster (CH)
Infrared Analysis Wastes	J. McClelland (AMES)	515-294-7948	S. Webster (CH)

NEEDS STATEMENT: CM-5

ID/IP: Characterization, Monitoring and Sensor Technology Integrated Program

Work Breakdown Structure Number: 01.05.01.01.08

Focus Area: Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization; Contaminant Plume Containment and Remediation; Facility Transitioning, Decommissioning and Final Disposition; Robotics

Description of Need: Sensor Development in Collaboration with the Robotics Program

This section describes sensor technology development needs in support of the Robotics Focus Area. The objectives of this effort are to provide remote sensing, operation and control of equipment to reduce worker exposure, to increase throughput of sample analysis, and to save cost. Specifications on the end product of the proposed sensor development such as geometry, weight, volume, power consumption, and supporting peripheral equipment need to be detailed.

Examples of sensor needs are grouped in the following types:

Physical State Sensors

- 3-D imaging and position sensors, especially ground-penetrating radar.
- Real-time, light-weight sensor to determine location of interface between waste and storage tank surface.
- Radiation, chemical, and environmentally hardened encoders; proximity and vision sensors.

Chemical Sensors

- Non-contact, real-time sensor for PCB detector for floors, walls and equipment.
- < 1 hour whole sealed drum and bin characterization to determine if lead or other hazardous materials are present.
- Real-time spectroscopy for detection of heavy metals and RCRA constituents.

Radiation/Electromagnetic/Geo-Physical Sensors

- Miniaturized alpha/gamma sensor to detect mixed waste samples.
- Portable, real-time detector to recognize isotopes by radiation emitted.
- Real-time detection and differentiation of uranium, thorium, and their daughter products.

Window of Opportunity: Present - FY 2000

Other Applicable IDs/IPs: RTDP, D&DID, BWID

Currently Related Tasks: None

NEEDS STATEMENT: CM-6

ID/IP: Characterization, Monitoring and Sensor Technology Integrated Program

Work Breakdown Structure Number: 01.05.01.01.08

Focus Area: Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization; Contaminant Plume Containment and Remediation; Facility Transitioning, Decommissioning and Final Disposition; Robotics

Description of Need: Sensor and Field Analysis Equipment

Sensor and field analysis equipment are needed to:

- Detect and monitor contaminants in soils, groundwater, waste containers and process effluents.
- Expedite site characterization.
- Monitor waste handling and waste treatment processes (e.g., retrieval of buried waste; chemical separation and treatment processes; and decontamination and decommissioning activities).

There is a special interest in sensors that are deployable by cone penetrometers or other minimally intrusive means for use in subsurface and groundwater environments. Sensors for monitoring off-gas from thermal treatment processes or for use in a robotic platform are not considered here. Their needs are described in separate sections.

Contaminants of concern are volatile organic compounds (VOCs) in soils and groundwater (excluding VOCs in soil gas); heavy metals, i.e., Hg, Pb, Cr^{VI} and As; nitrate and cyanide ions; radionuclides, i.e., Pu, U, Am, Th, Tc, ⁹⁰Sr, ¹³⁷Cs, and ³H; and polychlorinated biphenyls (PCBs). The VOCs of principal concern are trichloroethylene (TCE), perchloroethylene (PCE), carbon tetrachloride, and chloroform. Petroleum hydrocarbons are also of concern.

Window of Opportunity: Present - FY 2000

Other Applicable IDs/IPs: MWLID, BWID, VOCAID, USID, D&DID, RTDP, MWIP, ISRIP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Cone Penetrometer Support	J. Walker (ANL)	708-252-6803	S. Webster (CH)
TDR and Fiber Optic Probes for the Cone Penetrometer	R. Knowlton (SNL)	505-848-0425	P. Saxman (AL)

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Development of Screening and Quantitative Field Methods	P. Doskey (ANL)	708-252-7662	S. Webster (CH)
Sol-Gel Indication Program	G. Wicks (SRTC)	803-725-3190	M. O'Rear (SR)
Miniaturized Chemical FlowProbe Sensor Development	G. Laguna (SNL)	505-844-5273	P. Saxman (AL)
Multi-analyte, Single Fiber Optical Sensor	F. Milanovich (LLNL)	510-422-6838	R. Scott (SF)
Portable Acoustic Wave Sensor	G. Frye (SNL)	505-844-0787	P. Saxman (SF)
Chlorinated and Aromatic Hydrocarbon Thin Film Sensors	B. Swanson (LANL)	505-667-5814	P. Saxman (SF)
Remote Sensing Systems Development	L. Tinney (RSL)	702-295-8098	K. McWilliam (NV)
Air Quality Boundary Monitoring for VOCs	P. Hemberger (LANL)	505-665-5735	P. Saxman (AL)
Multi-Spectral Neutron Logging	J. Conaway (LANL)	505-667-2683	P. Saxman (AL)
Direct Sampling Ion Trap Mass Spectrometry	M. Wise (ORNL)	615-574-4862	J. Moore (OR)
SIMS Analysis	J. Delmore (ORNL)	208-526-2820	T. Williams (ID)
RCRA Metals Analysis by Laser-Induced Breakdown Spectroscopy	A. Koskelo (LANL)	505-665-4463	P. Saxman (AL)
Air Quality Monitoring for Alpha Contamination	D. MacArthur (SNL)	505-843-8943	P. Saxman (AL)
Direct Measurement Sr-90 and U-238 in Soils	A. Schilk (PNL)	509-376-9510	D. Trader (RL)
LA-ICP-AES Using a High Resolution Fiber Optic Interferometer	A. D'Silva (AMES)	515-294-9317	S. Webster (CH)
Improvements in ICP-MS	R. Houk (AMES)	515-294-9462	S. Webster (CH)

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Arrayed Sampler for Collection of Vadose Zone VOCs	R. Jenkins (ORNL)	615-576-8594	J. Moore (OR)
Technology Performance Specifications	M. Erickson (ANL)	708-252-7772	S. Webster (CH)

NEEDS STATEMENT: CM-7

ID/IP: Characterization, Monitoring and Sensor Technology Integrated Program

Work Breakdown Structure Number: 01.05.01.01.08

Focus Area: Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization; Contaminant Plume Containment and Remediation; Facility Transitioning, Decommissioning and Final Disposition; Robotics

Description of Need: Characterization Decision Support Tools

Two types of computer software are needed to help expedite site characterization and related activities: (1) tools to provide statistically based guidance for in-field, step-wise, dynamic planning and execution of site characterization activities; and (2) tools to facilitate the generation of graphic spatial displays of characterization information, including the concentrations of contaminants, geologic structure, hydrogeologic properties, and the associated measurement uncertainties.

Tools of the first type are needed, for example, to help decide where to sample or measure next, and when additional sampling or measurement is unlikely to add significant value to the characterization information already collected. Their application should be consistent with the Data Quality Objectives process (Neptune, Brantley, et al. 1990; Neptune, Moorhead, and Michael 1990).

Tools of both types are expected to be used together to facilitate site characterization planning and related decision-making; understanding of characterization and monitoring data; estimation and evaluation of contaminant migration potential and remediation alternatives; and communication with the public and regulatory agency personnel concerning site characterization activities and findings.

The desired tools must function or interface smoothly with each other and the computer systems, and other software tools commonly used for the generation of graphic spatial display of chemical, geologic, hydrologic, and geographic information. The tools must support the simultaneous spatial display of all the data types mentioned above, and the associated measurement, interpolation, or extrapolation uncertainties. They must support the display of field, laboratory, and other determinations of site characterization data and information. The tools (and appropriate computer hardware) should be usable in a field office environment located at the characterization site. Environmental professionals, such as chemists, geologists, hydrologists, and site remediation managers, should be able to apply them with ease after only minimal training.

Window of Opportunity: Present - FY 96

Other Applicable IDs/IPs: MWLID, BWID, VOCAID, USTID, D&DID, USID, ISRIP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Remote Sensing System Development	L. Tinney (RSL)	702-295-8098	K. McWilliam (NV)
Data Fusion for Characterization and Monitoring	S. Tomich (PNL)	509-376-9645	D. Trader (RL)
Data Fusion for Buried Waste Location and Monitoring	D. Yocky (SNL)	505-844-5188	P. Saxman (AL)
Contaminant Transport Modeling Studies of Russian Sites	C. Tsang (LBL)	510-486-5782	R. Scott (SF)

References:

- Neptune, M. D., E. P. Brantley, M. J. Messner, and M. D. Michael. 1990. Quantitative Decision-Making in Superfund: A Data Quality Objective Case Study. In *Hazardous Materials Control* Vol. 3, Number 3.
- Neptune, M. D., A. L. Moorehead, and M. D. Michael. 1990. Streamlining Superfund Soil Studies: Using the Data Quality Objective Process. In *Hazardous Materials Control. OSWER Proceedings*.

NEEDS STATEMENT: CM-8

ID/IP: Characterization, Monitoring and Sensor Technology Integrated Program

Work Breakdown Structure Number: 01.05.01.01.08

Focus Area: Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization; Contaminant Plume Containment and Remediation; Facility Transitioning, Decommissioning and Final Disposition; Robotics

Description of Need: Geophysical and Hydrogeologic Measurements

Information on site subsurface geologic structure and hydrogeologic properties is needed for estimation of contaminant migration and evaluation of remediation alternatives. Additional needs included in this section are non-intrusive or minimally intrusive methods for the characterization of burial trenches and pits, including boundaries and contents. Trench and pit contents of principal interest include uncontained wastes and waste containers that are made of metal, wood, and paper.

Specifically, the following are of interest:

- Improved in situ measurements of transport parameters (hydraulic conductivity, retardation factor, diffusion coefficient), physical properties (porosity, density, pressure), and moisture content in the unsaturated zone; and
- Improved accuracy, to ± 3 feet (1 ft. highly desirable), of locating trench or pit boundaries, of determining overburden depth, and of determining the center of odd-shaped objects larger than a 55-gallon drum.

Window of Opportunity: Present - FY 97

Other Applicable IDs/IPs: BWID, MWLID, VOCAID, UISID, RTDP, ISRIP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Cross-hole Compressional & Shear Wave Seismic Tomography	G. Elbring (SNL)	505-844-4904	P. Saxman (AL)
Electrical Resistance Tomography for Subsurface Imaging	W. Daly (LLNL)	510-422-8623	R. Scott (SF)
Analog Site for Characterization of Fractured Rock	J. Long (LBL)	510-486-6697	R. Scott (SF)

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Remote Sensing System Development	L. Tinney (RSL)	702-295-8098	K. McWilliam (NV)
Airborne Miniature Platforms	J. Nyquist (ORNL)	615-574-4646	J. Moore (OR)
Contaminant Transport Modeling Studies of Russian Sites	C. Tsang (LBL)	510-486-5782	R. Scott (SF)
International Environmental Assessment	D. Bradley (PNL)	509-376-2796	D. Trader (RL)
Zero Tension Lysimeters	M. Thompson (AMES)	515-294-1923	S. Webster (CH)
Rabbit Valley Geophysics	J. Dickerson (GJPO)	303-248-6293	P. Saxman (AL)

**MIXED WASTE
INTEGRATED PROGRAM**

3.2 Mixed Waste Integrated Program

Mixed Waste Problem

Mixed waste is an immediate and complex challenge to EM's waste management responsibilities. The Office of Technology Development must continue to address these major issues:

- DOE sites cannot treat 60 vol% (75% of waste streams) of currently stored waste using existing technology without modification.
- Deficiencies and gaps in existing technologies prevent fast and effective implementation of waste treatment systems.
- Federal and state laws and DOE compliance agreements require rapid commitment to schedules, technologies and facilities for treating mixed waste. This time constraint requires continued national coordination of a highly focused set of technology development initiatives to allow incorporation of innovative technologies, with commensurate cost savings.

Physical Situation

During the next five years, the DOE will manage over 1,200,000 m³ of mixed low-level waste and mixed transuranic waste at 50 sites within 22 states (see Table 3.1). More than 1200 individual mixed waste streams are comprised of various chemical matrices containing a wide range of both hazardous and radioactive contaminants. Since these waste streams were generated over a 50-year period, the containment and packaging varies widely (e.g., drums, boxes, buried waste). Heterogeneity makes characterization difficult — implementation of sampling plans is costly and causes risk to workers, while representative samples are hard to obtain.

DOE-managed mixed waste has been categorized into treatability groups attempting to clarify this complex situation. The volume of each major treatability group has been estimated and can serve to focus technology development initiatives for mixed waste treatment.

Regulatory Situation

Mixed waste contains hazardous waste (governed by the Resource Conservation and Recovery Act (RCRA)), and radioactive contaminants (governed by DOE Orders). Requirements specified under these regulations sometimes conflict. Generally, RCRA requirements are prescriptive, while DOE Orders generally require interpretation (compare: RCRA Land Disposal Requirements for leach rates of hazardous species and DOE Order for performance assessments of radionuclide migration from a disposal site).

Table 3.1. DOE-Managed Mixed Low-Level Waste and Mixed Transuranic Waste Volumes.

Source of Mixed Waste	Volume (m ³)
Current Site Inventories	
Mixed Low-Level Waste	247,036
Mixed Transuranic Waste	57,945
Operations Generated (Five-Year Projection)	
Mixed Low-Level Waste	279,900
Mixed Transuranic Waste	2,840
Environmental Restoration (Five-Year Projection)	
Mixed Low-Level Waste	620,000
Mixed Transuranic Waste	330
Total	1,208,051

Disposal criteria have not been established for mixed waste. Selection of disposal sites, and, in turn, radioactive disposal criteria, should be based on performance assessments. Performance assessments for radioactive waste disposal do not take credit for the form of the waste. Delisting of mixed waste from regulation under RCRA after treatment has not been accepted/approved. Treatment of mixed waste using the debris rule has not been demonstrated/approved. No de minimus level exists for radioactivity. The risks to public and workers due to storage of legacy waste is not well defined; therefore, priorities cannot be established on a risk-based cleanup strategy.

The Congress recognized problems associated with mixed waste management and enacted the Federal Facility Compliance Act of 1992. The Act waives sovereign immunity for Federal facilities, thereby allowing DOE to be subject to fines and penalties for failure to manage mixed waste according to RCRA. This congressional mandate for the DOE to treat its mixed waste establishes a 3-year timetable (ending in October 1995) for development of site treatment plans, during which time the waiver of sovereign immunity is delayed. The Act gives states approval authority over the site treatment plans. Differing state requirements for the treatment plans are anticipated. After plans have been reviewed, it is further anticipated that equity brokering between states will occur regarding treatment, storage and disposal facility location. The National Governors' Association is providing a forum for states, EPA and DOE to discuss FFCAct implementation. The Western Governors' Association is actively seeking feedback from industry, and has formed the DOIT (Development of On-Site Innovative Technologies) committee to foster the development of innovative technologies for mixed waste management.

Environmental restoration waste is regulated under state laws, Nuclear Regulatory Commission regulations, RCRA, and CERCLA. Federal Facility Agreements have been negotiated at each site with a timetable for restoration of facilities. The restoration of a particular waste area group, or operable unit, is determined through the formal CERCLA process. This process uses specific technology selection criteria and analysis. Waste streams are identified in the Records of Decisions that are generated through the CERCLA process. Generally, environmental restoration mixed waste streams will result from soils or groundwater restoration, or facility D&D activities. However, until a ROD is established, there is uncertainty regarding the resulting waste stream types, composition,

and volume -- the information evolves as the CERCLA process is followed. For example, were a no-action decision reached, there would be no resulting waste streams.

At several sites, a general public distrust of DOE makes it difficult to permit processes. This leads to subsequent delays or prevents deployment of solutions. For example, the lack of public acceptance of incineration has caused difficulty in obtaining permits; however, incineration is the "best demonstrated available technology" for treatment of combustible waste. Therefore, technical issues are linked to legal or perceptual issues, making overcoming "major obstacles to progress" a complex process.

Technology Development

In response to the need for a comprehensive and consistent approach to mixed waste technology development, the Office of Technology Development has established the Mixed Waste Integrated Program (MWIP) to ensure that treatment capability is developed. This program is problem-oriented, and supports DOE waste management needs and environmental restoration needs. MWIP has identified technology areas that cover the range of processes required. The program work breakdown structure reflects technology areas as follows: (1) materials handling, (2) chemical/physical treatment, (3) waste destruction/stabilization, (4) off-gas treatment and final waste forms production and assessment, (5) systems integration, and (6) process monitoring and controls.

Emerging Technologies Systems Integration

Mixed waste technologies must be capable of processing a range of types and levels of radioactivity, hazardous constituents and waste matrices. The complex combination of mixed waste characteristics makes the need for treatment trains (i.e., series of unit operations) apparent. The performance requirements for and capacity of treatment trains will vary, due to the wide spectrum of waste volumes, packaging, chemical matrices, contaminants, and extent of waste stream characterization; therefore, technology cannot be developed "a project at a time"; the analysis of problems and development of technical solutions must be conducted using a systems approach. Methodologies to evaluate technical solutions for process performance, risk, cost, and regulatory acceptance have been developed, but are not widely accepted because a pathway to acceptability has not been established.

Regulatory and public issues must be integrated with technical issues and treated on a systems basis. Methodologies for obtaining public involvement are implemented through site-specific efforts and do not, necessarily, support the implementation of innovative technologies. Office of Technology Development efforts to provide technical assistance regarding mixed waste treatment options and innovative technologies to the Office of Waste Management have been initiated.

Adaptation of Commercially Available Equipment

Existing technical solutions are inadequate — 60 vol% of mixed waste (75% of waste streams) require improvements to existing technology before waste can be treated (see Table 3.2). Processes available to treat hazardous constituents have had limited demonstrations for the treatment of hazardous and radioactive constituents. The fate of the radioactive species in these processes has not been fully determined. Only a few waste streams have been identified that have no treatment capability. It is evident that improvement of technologies is the primary challenge of mixed waste technology development.

Table 3.2. Applicability of Existing Treatment Technologies to DOE Mixed Waste.

Low-Level Waste Streams	Treatment technology exists		Treatment technology exists, but needs modification		Status undetermined	
	Number of streams	Quantity (m ³)	Number of streams	Quantity (m ³)	Number of streams	Quantity (m ³)
Contact handled:	304	93,000	797	81,000	85	28,700
Remote handled:	9	6,000	13	38,400	2	10
Total MLLW Percent	313 25%	99,000 40%	810 65%	119,400 48%	120 10%	28,710 12%

MWIP MISSION

The MWIP identifies, develops, and demonstrates technologies for treatment of DOE mixed low-level wastes into forms acceptable for disposal. These technologies must have improved performance, reduced risk, and minimized life-cycle costs over existing technology, or provide treatment for waste streams for which no current treatment technology exists.

Objectives have been established to achieve the stated mission through both development of innovative technology and evaluation of existing technology for the solution of mixed waste treatment problems.

- (1) Develop and demonstrate improved or alternative technologies to and filling technology gaps in, baseline treatment plans developed by the Office of Waste Management using actual DOE mixed waste streams.
- (2) Develop mixed waste treatment technologies, such as mobile treatment units, for DOE mixed wastes that have limited treatment capacity requirements.
- (3) Assess the need for and prove the feasibility of production of enhanced waste form(s) for low-level mixed waste.
- (4) Develop and demonstrate the capability to characterize to treat to assure appropriate, but not excessive up-front characterization, while treating to meet disposal requirements.

TECHNOLOGY DEVELOPMENT OPPORTUNITIES

Significant problem-oriented technology development is in progress (see Table 3.3); therefore, narrowly-defined technology development needs have been identified. Technology development

opportunities exist within the following technology areas: chemical/physical treatment; waste destruction/stabilization; off-gas treatment; and final waste forms production and assessment.

Table 3.3. FY 93 Mixed Waste Technology Development Activities.

Waste Streams	Sludges Aqueous and organic liquids	Heterogeneous Debris	Organic Liquid	Special Waste
Technical Area	Soils			
Material Handling		<ul style="list-style-type: none"> • Characterize to treat • Remote material handling 		
Chemical/Physical Treatment	<ul style="list-style-type: none"> • Biocatalyst destruction of nitrite/nitrate • Freeze crystallization technology 	<ul style="list-style-type: none"> • Decontamination of equipment, containers 		<ul style="list-style-type: none"> • Mercury control technologies
Waste Destruction/Stabilization	<ul style="list-style-type: none"> • Steam reforming of organics and nitrates • Fixed-hearth plasma-arc furnace 	<ul style="list-style-type: none"> • Fixed-hearth plasma-arc furnace 	<ul style="list-style-type: none"> • Steam reforming of organics and nitrates 	
Off-gas Treatment	<ul style="list-style-type: none"> • Monitoring using tunable diode laser • Real-time monitoring of alpha emissions • Membrane/Steel HEPA filter 	<ul style="list-style-type: none"> • Real-time monitoring of alpha emissions • Membrane/Steel HEPA filter 	<ul style="list-style-type: none"> • Monitoring using tunable diode laser • Real-time monitoring of alpha emissions 	<ul style="list-style-type: none"> • Elemental, total speciated mercury monitor • Mercury vapor removal and control • Real-time monitoring of alpha emissions
Final Waste Forms	<ul style="list-style-type: none"> • Chemically bonded ceramics • Polyethylene • Vitrification 			<ul style="list-style-type: none"> • Sulfur polymer cement

Each technology alternative must be reviewed in relation to the system for which it is proposed. Evidence that principal investigators understand the proposed work in the context of MWIP objectives and systems, and present a scientifically-valid approach, will be weighed heavily in final proposal selection. Technology development may involve laboratory, bench-scale, and/or integrated small-scale equipment testing and demonstrations of specific portions of the flowsheet.

Researchers with questions about a given technology area should contact:

Paul Hart, Ph.D.
Program Manager
U.S. DOE
(301) 903-7456

Jan Berry
Technical Program Coordinator
Oak Ridge National Laboratory
(615) 574-6907

Clyde Ward
Materials Handling
SRTC
(803) 725-5891

Cliff Brown
Chemical/Physical Treatment
Rocky Flats Plant
(303) 966-3667

John McFee
Waste Destruction/Stabilization
IT Corporation
(505) 262-8740

Nina French
Off-Gas Treatment
SNLCA
(510) 294-3185

John Mayberry
Final Waste Forms
SAIC-Idaho
(208) 528-2116

NEEDS STATEMENT: MW-1**ID/IP: Mixed Waste Integrated Program****Work Breakdown Structure Number: 01.05.01.02.05****Focus Area: Mixed Waste Characterization, Treatment, and Disposal****Description of Need: Closed Loop Off-gas Systems**

In the Off-gas Treatment technical area, there is a need to develop/demonstrate a closed-loop off-gas system for thermal treatment processes used to treat mixed waste. Current technologies for thermal treatment of mixed waste of interest to MWIP include incinerators, vitrifiers, and plasma furnaces. However, these types of processes emit an off-gas that contains pollutants such as toxic heavy metals, radionuclides, and acid gases. Even with the use of pollution control devices that minimize the release of these pollutants, there is public concern over the use of these thermal treatment processes because of the emissions, as well as the lack of real-time instrumentation to monitor the releases of heavy metals, each of the radionuclides, and various hydrocarbon species. Use of a closed-loop off-gas system can help alleviate these concerns and significantly reduce the difficulty in sighting and permitting a mixed waste thermal treatment facility.

Window of Opportunity: FY 94 - 97**Other Applicable IDs/IPs: CMST****Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Continuous Monitor Tunable Diode Laser for NH ₃	D. Ottesen (SNLCA)	510-294-3567	P. Saxman (AL)
Control and Recovery of Vapor Phase Mercury	D. Sparger (SNLCA)	510-294-2537	P. Saxman (AL)
Development of a Real-Time Monitor for Alpha Emissions	R.E. Gritzo (LANL)	505-667-0481	P. Saxman (AL)
Continuous Monitor for Mercury in Gases and on Solids	J. Wang (SNLCA)	510-294-2786	P. Saxman (AL)

NEEDS STATEMENT: MW-2**ID/IP: Mixed Waste Integrated Program****Work Breakdown Structure Number: 01.05.01.02.05****Focus Area: Mixed Waste Characterization, Treatment, and Disposal****Description of Need: Expedited Demonstration of a Mixed Waste Treatment Technology**

In the area of Chemical/Physical Treatment & Waste Destruction & Stabilization, there is a need to perform expedited treatment demonstrations on mixed waste streams employing new or existing (modified for the treatment of radionuclides) waste treatment technologies. Upon proposal approval and release of funds, the expedited demonstration would be expected to occur within one year. Proposals received for review should address permitting issues, mixed waste stream candidates, private sector participation and a specific timeline for achieving the demonstration in one year on an actual mixed waste stream. Several technologies currently being demonstrated include vitrification, plasma arc destruction and steam reforming. New activities are not needed in these areas. The major thrust will be towards technologies that treat a wide variety of waste streams or the highest volume streams in the inventory (sludges, solids), and private sector participation.

Window of Opportunity: FY 95 - 96**Other Applicable IDs/IPs:****Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Steam Reforming of Mixed Waste	L. Bustard (SNL)	505-845-8661	P. Saxman (AL)
Plasma Hearth Process Radioactive Test	G.C. McClellan (WHC)	208-533-7257	T. Williams (ID)
Low-Level Mixed Waste Vitrification Process Limits	D.F. Bickford (SRTC)	803-725-3737	M. O'Rear (SR)

NEEDS STATEMENT: MW-3**ID/IP: Mixed Waste Integrated Program****Work Breakdown Structure Number: 01.05.01.02.05****Focus Area: Mixed Waste Characterization, Treatment, and Disposal****Description of Need: Development of Process Monitoring and Control Waste Treatment Technology**

In the Systems Analysis technical area, there is a need to develop hardware and software systems that support thermal and non-thermal treatment technologies for low-level mixed waste. Systems that are capable of interfacing several treatment technologies are desired. Process monitoring and control systems proposed should be capable of continuously monitoring all aspects of a given treatment system (air contaminants, temperature, pressure, feed rate, final form, etc.) and perform real-time feedback of the data to control the system.

Especially important to this need is real-time monitoring of off-gas species such as radionuclides, heavy metals, carbon monoxide and hydrocarbons. Proposals that include overall process control will be evaluated more closely.

Window of Opportunity: FY 95 - 97**Other Applicable IDs/IPs: CMST-IP****Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Process Monitoring and Control	K.P. Carney (INEL)	208-533-7263	T. Williams (ID)
Waste Stream Diagnostics And Control for Treatment of MW	W.D. Bostick (ORNL)	615-574-6825	J. Moore (OR)
Diagnostic & Control Analytical Laboratory (DIAL) at Mississippi St. Univ.	W. S. Shepard (MSU)	601-325-2105	S. Webster (CH)

NEEDS STATEMENT: MW-4

ID/IP: Mixed Waste Integrated Program

Work Breakdown Structure Number: 01.05.01.02.05

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

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Description of Need: Application of the Debris and Empty Container Rules

In the Chemical/Physical Treatment technical area, there is a need to apply the Debris and Empty Container Rules to mixed waste treatment, which can result in the following:

- Simplify processes and associated characterization requirements.
- Shorten the RDDT&E timeframe, since alternate treatment technologies are Best Demonstrated Available Technologies (BDAT).
- Reduce the cost of processing and disposal by existing RCRA regulations.

To date, all work conducted toward evaluating debris technologies (extraction, destruction, and immobilization) has focused on hazardous waste. Now there is a need to explore the performance of the debris technologies to mixed waste.

Demonstration, testing, and evaluation is leading to performance measurement of a debris technology with actual mixed waste debris. The evaluation should measure performance standards, evaluate safety, determine secondary waste generation, measure radioactive constituent behavior, and perform an equivalency determination for thermal desorption, biological/chemical destruction, or for any non-BDAT method.

Window of Opportunity: FY 95 - 98

Other Applicable IDs/IPs: None

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Treatment Technology Analysis for Mixed Waste Containers and Debris	R.J. Gehrke (INEL)	208-526-4155	T. Williams (ID)

NEEDS STATEMENT: MW-5

ID/IP: Mixed Waste Integrated Program

WBS No.: 01.05.01.02.05

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

Description of Need: Low-Temperature Mixed Waste Treatment Processes

In the Waste Destruction/Stabilization technical area, research, development, demonstration, testing, and evaluation of emerging alternatives to thermal waste destruction technologies capable of treating a wide variety of DOE wastes is needed to simplify waste processing, respond to stakeholder concerns, and lower life-cycle costs (a non-thermal treatment option is one that treats one or several DOE heterogeneous wastes at low temperature (an approximate 300°C limit) and converts hazardous organics and organic matrices into gaseous products or inorganic salts). Processes that can treat heterogeneous wastes including mixed solids, metals, inerts, organics, sludges, and previously solidified wastes are of interest. This work will involve engineering studies and technology demonstrations to bring the technology to full-scale implementation.

Certain applications of Wet Oxidation, Acid Digestion, and Chem Char technologies may meet the specified need. Other technologies can be considered if the requirements are met.

General requirements of proposed technologies:

- Proposed technologies must be able to treat a wide variety of waste streams. These wastes must be identified, along with references to any prior testing of the waste streams.
- Information on process residue volumes and immobilization options must be provided. The process residues should be very low in residual organic materials, and preferably low in elemental (fixed) carbon.
- Process information identifying destruction chemistry is required.
- Information on life-cycle costs must be provided.
- The process should not result in an excess safety hazard over existing technologies.
- Bench-scale or larger test results should be referenced or provided.

Window of Opportunity: To meet the MWIP needs, a bench-scale or pilot-scale demonstration of the process must be completed by FY 96.

Other Applicable IDs/IPs: This technology would be particularly applicable to sites where stakeholder demands make thermal technologies difficult or impossible; therefore, the Rocky Flats IP should be applicable. In addition, any IP or ID involving waste destruction is a possible candidate.

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
MWIP Draft Document, Alternatives to Thermal Treatment Technologies	L. Nenninger (SAIC)	301-924-6170	None

NEEDS STATEMENT: MW-6

ID/IP: Mixed Waste Integrated Program

Work Breakdown Structure: 01.05.01.02.05

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

Description of Need: Long-Term Performance Assessment of Final Waste Forms

In the Final Forms technical area, there exists a critical concern in assessing the long-term performance of a disposal facility in the durability of the solidified waste. Leaching of toxic components of the waste has been identified as the first step by which these metals impact human health. The capacity of the waste form to resist leaching is directly related to its ability to retain its physical and chemical character over time. The ability to predict physical and chemical integrity of the solidified waste, over time, needs to be developed as a final waste form test procedure. Related to the issue of integrity, the mechanisms by which waste forms release their toxic constituents need to be understood and modeled. MWIP-developed waste surrogate waste recipes will be used as waste input. Copies of DOE/MWIP-18 "Surrogate Formulations for Thermal Treatment of Low-Level Mixed Waste: Part IV — Waste Water Treatment Sludges" may be obtained from John Mayberry, 208-528-2116.

Window of Opportunity: FY 94 - mid/96

Other Applicable IDs/IPs:

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Performance Criteria	E. Franz (BNL)	516-282-7103	S. Webster (CH)

**IN SITU REMEDIATION
INTEGRATED PROGRAM**

3.3 In Situ Remediation Integrated Program (ISRIP)

The In Situ Remediation Integrated Program develops in situ technologies to remediate contaminated groundwater and soils in an Integrated Demonstration or for immediate use by the customer (i.e., the Office of Waste Management, the Office of Environmental Restoration, or the Office of Facility Transition and Management). The ISRIP is divided into four sub-programs: (1) Containment, (2) Chemical/Physical Treatment, (3) Biological Treatment, and (4) Subsurface Manipulation. In FY 95, the ISRIP will focus on tools for installing subsurface barriers and in situ bioremediation. Specific needs include:

Containment

- Emplacement technologies for installing horizontal and angled barriers beneath waste sites.
- Emplacement technologies for viscous liquid barriers.
- Emplacement technologies for installing permeable reactive barriers.
- Integrity verification of subsurface barriers and performance monitoring.

In Situ Bioremediation

- Methods to increase rates of in situ bioremediation of DNAPLs.
- Methods for improving the efficiency of the degradation of chlorinated solvents.
- Biostimulation for the remediation of mixtures of chlorinated solvents.
- Bioaugmentation for the biological treatment of mixtures of chlorinated solvents.
- Rapid method to detect in situ biodegradation products.
- Biotreatment technologies for toxic inorganics and radionuclides.

A summary of current ISRIP technology development efforts is available from:

Mary E. Peterson
Technical Program Coordinator
Battelle, Pacific Northwest Lab
P.O. Box 999
Battelle Blvd
Richland WA 99352
509-372-4655

Jeffrey S. Walker
ISRIP Program Manager
Department of Energy
19901 Germantown Road
Germantown, MD 20874
301-903-7966

NEEDS STATEMENT: IS-1

ID/IP: In Situ Remediation Integrated Program

Work Breakdown Structure Number: 01.05.01.01.09

Focus Area: Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization
Contaminant Plume Containment and Remediation

Description of Need: Methods to increase rates of in situ bioremediation of DNAPLs

Goal: Develop techniques for enhancing bioavailability of Dense Non-Aqueous Phase
Liquids (DNAPLs) for bioremediation by 1997

Proposed research should conduct quantitative bench-scale studies of methods to increase bioavailability of contaminants or to increase rates of biodegradation of DNAPLs. Anticipated work includes examination of the use of surfactants (including biosurfactants) to increase rates of DNAPL degradation, methods to increase production of biosurfactants from natural populations, and promising techniques for bioaugmentation. The bioaugmentation task may include examination of strains of microbes capable of direct or nearly direct degradation of DNAPLs that are resistant to high concentrations and can degrade sorbed contaminants.

Research projects should address the types of soils and compounds found at DOE sites. This evaluation must be supported with laboratory technical data of sufficient quality and applicability that the technology can be reliably evaluated for demonstration at any DOE site.

Other Related ID/IPs: VOCs in Arid Soils, Non-VOCs in Non-Arid Soils

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
NAPL Contaminated Soil/Groundwater Remediation Using Foams	J.E. Helt (ANL)	708-252-7335	S. Webster (CH)

NEEDS STATEMENT: IS-2

ID/IP: In Situ Remediation Integrated Program

Work Breakdown Structure Number: 01.05.01.01.09

Focus Area: Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization
Contaminant Plume Containment and Remediation

Description of Need: Improved efficiency for degradation of chlorinated solvents.

Goal: Complete development of in situ bioremediation for single organic contaminants (specifically trichloroethylene, tetrachloroethylene, carbon tetrachloride, and chloroform) for groundwater remediation by 1995.

DOE has performed or is planning several field demonstrations of in situ bioremediation technologies. This need area seeks to resolve any technical issues identified during these demonstrations to enable the transfer of the technology to other DOE sites.

Anticipated work includes:

- improving the efficiency (rate, percent degraded, by-products formed) through the identification of degradation mechanisms and metabolic pathways, especially for carbon tetrachloride and chloroform.
- identifying copper-resistant strains for methanotrophic degradation of TCE.
- improving operational procedures for anaerobic and aerobic degradation processes for carbon tetrachloride/chloroform.
- identifying nutrients, their optimal chemical forms (i.e., nitrous oxide, nitrate ion, or ammonium ion) and ratios/concentrations for anaerobic degradation of chlorinated solvents.

Research projects should address the types of soils and compounds found at DOE sites. This evaluation must be supported with laboratory technical data of sufficient quality and applicability so the technology can be reliably evaluated for application at any site.

Other Related ID/IPs: VOCs in Arid Soils, Non-VOCs in Non-Arid Soils

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Bioremediation of PCB Contamination	K.T. Klasson (ORNL)	615-574-6813	J. Moore (OR)
Mixed Chlorinated Solvent Bioremediation in the Unsaturated Zone	R. Skeen (PNL)	509-375-3903	D. Trader (RL)

NEEDS STATEMENT: IS-3

ID/IP: In Situ Remediation Integrated Program

Work Breakdown Structure Number: 01.05.01.01.09

Focus Area: Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization
Contaminant Plume Containment and Remediation

Description of Need: Biostimulation of Mixtures of Chlorinated Solvents.

Goal: Develop in situ bioremediation of soil contaminated by mixtures of chlorinated solvents by 1996.

Chlorinated alkanes and alkenes are primary contaminants and co-contaminants at many DOE sites. There have been significant efforts in laboratory and field investigations on the aerobic biodegradation of TCE using methanotrophic processes. However, many DOE sites are contaminated with mixtures of chlorinated solvents including PCE, TCE, CCl_4 , CHCl_3 and TCA. Only TCE and CHCl_3 are readily biodegradable under methanotrophic conditions.

The proposed research should conduct quantitative bench-scale studies of biostimulation methods addressing mixtures of chlorinated solvents, primarily PCE, TCE, CCl_4 , CHCl_3 and TCA. This research is to be conducted under anaerobic conditions and can include sulfate reduction and/or methanogenesis. Since published information on anaerobic treatment has emphasized PCE and TCE, primary importance is given to the anaerobic transformation of CCl_4 , TCA and CHCl_3 . It is suggested that bacterial consortia be evaluated, rather than pure strains. Research should be conducted under conditions where material balances can be achieved. Investigators may choose to investigate the anaerobic fate of single compounds, but emphasis should be on the biodegradation of mixtures of the five compounds listed above. Concentrations of chemicals in the mixture should be studied in a range from 100 ppb to 10 ppm.

The expected outcome of this research is an increased understanding of biodegradation rates and efficiency, and better control of in situ bioremediation processes for the destruction of mixed chlorinated solvents. Better descriptive models of the in situ bioremediation processes are sought, as well as performance evaluation of the proposed process on the types of soils and compounds found at DOE sites. This evaluation must be supported with laboratory technical data of sufficient quality and applicability so the technology can be reliably evaluated for demonstration at any DOE site.

Other Related ID/IPs: VOCs in Arid Soils, Non-VOCs in Non-Arid Soils

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Mixed Chlorinated Solvent Bioremediation in the Unsaturated Zone	R. Skeen (PNL)	509-375-3903	D. Trader (RL)

NEEDS STATEMENT: IS-4

ID/IP: In Situ Remediation Integrated Program

Work Breakdown Structure Number: 01.05.01.01.09

Focus Area: Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization
Contaminant Plume Containment and Remediation

Description of Need: Rapid Method to Detect In Situ Biodegradation Products

Goal: Develop the techniques for determining the performance and extent of bioremediation and fate of contaminants, including the fate/performance of natural (intrinsic) attenuation by 1996.

One problem with in situ bioremediation is determining the functional capability of the environment to degrade a contaminant, and the activity of degraders that are present or are being stimulated. In order for in situ bioremediation to be properly implemented and controlled, rapid measurements of these parameters are essential. Areas of interest are:

- Nucleic acid probes to indicate the total amount of genetic code for a contaminant degrading enzyme (DNA/RNA) and the relative activity by quantifying the mRNA concentrations for these enzymes. New, improved, or automated techniques for rapid nucleic acid extraction, purification, isolation, and increased sensitivity of nucleic acid probes as a characterization and monitoring tool for in situ bioremediation need to be developed. Proposed work should focus on improving nucleic acid recovery and probe sensitivity in the application of these probes to actual bioremediation projects (note that PCR techniques have previously been applied to DOE projects; use of PCR alone for selected probes is not considered a valid research project for this need).
- Innovative ways to determine the rate and extent of biodegradation of chlorinated solvent mixtures using stable isotope measurements of carbon and chlorine need to be investigated. Research should analyze the possibility that different chlorinated solvent classes have different stable isotope signals that will allow mineralization products (carbon dioxide, microbial biomass, bound residues, and chloride release) to be tracked and distinguished in environmental samples. Research should also develop procedures and mechanisms for obtaining mass balance in the laboratory and the field by monitoring the disappearance, assimilation, and respiration of target chemicals.
- Technologies for the down-hole or in situ detection of biodegradation products in real time or short time (less than one day) are needed. Products resulting from the in situ biodegradation of chlorinated hydrocarbons (e.g. TCE, TCA, DCE, PCE, and CCl_4) exist in the subsurface. Concentrations of these products (e.g. ethanes, ethenes, dichloroethylenes, vinyl chloride, and epoxides of these compounds) in the subsurface range from low parts per million to parts per billion, at depths ranging from 0-500 feet.

Projects in this area must propose a program for initiating studies at the bench scale, proceeding to soil and groundwater test cells, and then finally moving to field-scale demonstration. Interfacing the field mass balance approaches with the use of (or development of) mathematical models is encouraged.

The expected outcomes of this research include a new capability to rapidly perform quantitative and qualitative assessments of bioremediation activities, better control of in situ bioremediation processes, reduced costs for verifying mass balance and biodegradation, and reliable measurement of natural attenuation. Products of this research must be developed for eventual use at actual bioremediation projects by those responsible for the remediation.

Other Related ID/IPs: VOCs in Arid Soils, Non-VOCs in Non-Arid Soils

Currently Related Tasks: None

NEEDS STATEMENT: IS-5**ID/IP:** In Situ Remediation Integrated Program**Work Breakdown Structure Number:** 01.05.01.01.09**Focus Area:** Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization
Contaminant Plume Containment and Remediation**Description of Need:** Biotreatment Technologies for Toxic Inorganics and Radionuclides**Goal:** Advance biotreatment of heavy metals and radionuclides past conceptual stage to demonstration by 1997.

Many DOE sites are contaminated with heavy metals and other toxic elements and radionuclides in subsurface and surface soils. Major toxic inorganics are Pb, Cr, As, Zn, Cu, Hg, Cd, while major radionuclides at DOE sites are T, U, Sr-90, Pu, Cs-137, and Tc. These are often found in combinations with each other and with toxic organics, particularly chlorinated solvents (TCE and CCl₄). The treatment of these sites requires a two- or three-step process: metals must be removed from the soil particles, then either chemically altered to reduce toxicity, or concentrated in a form that can be easily recovered, and finally flushed from the subsurface and recovered.

Proposed work should include quantitative bench-scale studies of concepts for mobilization, concentration and subsequent recovery of toxic elements and radionuclides in the subsurface, which cannot be readily removed by groundwater pumping or soil washing. Processes of interest include microbial production of chelators (including organic acids), and microbial oxidation/reduction of heavy metals. Proposals in this area should include an optional pilot-scale experiment (approximately 20 to 30 cubic yards of soil) to demonstrate hydraulic control of the mobilized metal.

Research projects should address types of soils and metals found at DOE sites. This evaluation must be supported with laboratory technical data of sufficient quality and applicability for the technology to be reliably evaluated for demonstration at any DOE site.

Other Related ID/IPs: VOCs in Arid Soils, Non-VOCs in Non-Arid Soils, Mixed Waste Landfill, Buried Waste, Mixed Waste, Underground Storage Tanks**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPQ</u>
Biosorption of Uranium	B. Faison (ORNL)	615-576-0484	J. Moore (OR)
Biomass Remediation System	W. Goldberg (MSE)	406-723-8225	G. Staats (PETC)

NEEDS STATEMENT: IS-6

ID/IP: In Situ Remediation Integrated Program

Work Breakdown Structure Number: 01.05.01.01.09

Focus Area: High-Level Waste Tank Remediation; Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization; Contaminant Plume Containment and Remediation

Description of Need: Emplacement Technologies for Installing Horizontal and Angled Barriers Beneath Waste Sites

Goal: Develop new technologies for horizontal and angled barriers (both permeable and impermeable) and obtain verified performance data by 1996.

A need exists to develop and field test a means of mechanically mixing or emplacing barrier-forming liquids and solids into the soil beneath waste sources, to create a permeable or impermeable continuous barrier. Soil properties range from clays typically found on the east coast, to the sandy/gravelly soil found at Hanford. Some waste sites feature the presence of cobbles, boulders, and agglomerated soils. The required depth of the barrier typically ranges from 10 to 60 feet. Special cases exist where a barrier may be required at a depth greater than 200 feet. The required area of a barrier beneath a waste site ranges from a fraction of an acre to more than 100 acres.

The primary challenge in this need area is achieving uniform mixing or emplacing of the soil and barrier-forming materials necessary to create a continuous barrier. The barrier emplacement technology must be consistent with constraints posed by the barrier-forming materials (e.g., Portland cement sets over time and cannot be remixed). A horizontal barrier must also be capable of being joined to a vertical barrier to create a leak-tight basin for the case when an impermeable barrier is required. A technology capable of creating V-shaped barriers will be considered. The technology must be consistent with the requirement that (1) the integrity of the barrier be verifiable during or immediately after its installation, and (2) the performance of the barrier can be monitored over its design lifetime.

The expected outcome of the effort includes development and/or adaptation of equipment capable of installing barriers beneath waste sites, and testing and evaluation of their critical components in the field. The evaluation must be assess feasibility, applicability, and cost-effectiveness of the technology and quality of the barrier produced.

The scale of testing should result in a barrier approximately 50 ft. by 100 ft., which can be scaled-up to larger dimensions. Research proposals should define the parameters that will be measured and describe the approach for obtaining measurements. After the barrier is emplaced and tested, it shall be uncovered and visually inspected. Additional laboratory testing of samples of the barrier to verify uniformity shall be defined in the proposal. The successful proposer must involve the participation of industry (engineering firms and/or equipment companies, as applicable). The involvement of experts at national laboratories and universities is strongly encouraged. Subcontracts with industry and other experts, as appropriate, must be established on a schedule that enables completion of work within 3 years. Cost effectiveness and performance in subcontracting to industry will be considered during the review of proposals for this need.

Other Related ID/IPs: VOCs in Arid Soils, Non-VOCs in Non-Arid Soils, Mixed Waste Landfill, Buried Waste, Mixed Waste, Underground Storage Tanks

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Developing/Demonstrating Methods of Placing In Situ Grout Barriers	D.E. Ridenour (FERMCO)	513-738-6772	R. Warner (FN)
Soil Freezing Technology Applications	R.E. Adams (ORNL)	615-435-3115	J. Moore (OR)
Mixed Waste Landfill ID: Hybrid Directional Boring and Horizontal Logging	B. Wemple (SNL)	505-844-2230	P. Saxman (AL)
Mixed Waste Landfill ID: Anlge Drilling and Boring Using Sonic Technology	J.W. Mercer (SNL)	505-845-7562	P. Saxman (AL)

NEEDS STATEMENT: IS-7

ID/IP: In Situ Remediation Integrated Program

Work Breakdown Structure Number: 01.05.01.01.09

Focus Area: High-Level Waste Tank Remediation; Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization; Contaminant Plume Containment and Remediation

Description of Need: Emplacement Technologies for Viscous Liquid Barriers

Goal: Develop methodologies to efficiently emplace viscous liquid barriers by 1996.

Viscous liquid barriers are a relatively new class of impermeable barriers. They can be installed as horizontal and/or vertical barriers. The barrier material is emplaced as a low-viscosity liquid which, after emplacement, forms an impermeable high-viscosity barrier under the ambient subsurface conditions. Several classes of materials (e.g., colloidal silica gels, waxes, polysiloxanes and polybutenes) have been or are being developed for use as viscous liquid barriers. The desired viscosity characteristics (i.e., initial low viscosity to facilitate subsurface emplacement and high post-emplacement viscosity) are achieved, for example, by heating the material during emplacement or by promoting polymerization or gellation after emplacement. To meet the DOE need, it will be necessary to emplace the viscous liquid barriers in horizontal (floor) and vertical (wall) configurations (or possibly in V- or bowl-shapes).

The properties of viscous liquids make them amenable to subsurface manipulation techniques that can be applied to facilitate emplacement within the soil. For example, some materials can be made to flow preferentially into heated zones, and electrolyte materials can be made to flow in the direction of a voltage gradient.

New activities should develop and evaluate at small scale (20 to 40 CY tank), methods for emplacing and evaluating the integrity of viscous liquid barriers. Innovative approaches and adaptations of existing technologies are encouraged. Proposals must include an option for the full-scale demonstration of the technology after it has been tested at pilot scale. Proposals that address barrier emplacement using adaptations of conventional technologies (e.g., injection or permeation grouting), in conjunction with heated liquid delivery and subsurface heating systems, may be moved directly into field demonstration without first evaluating the technology at pilot scale. The work scope for the field demonstration should address emplacement and testing of prototype horizontal (approximately 100 - 500 ft² at a depth of about 10 to 20 ft) and vertical (approximately 10 ft high by 50 ft long) barriers in either the vadose or saturated zones. The field test location should be instrumented to monitor the effects of emplacement (e.g., local soil heave and effects of subsurface heating) and the performance (e.g., hydraulic conductivity) of the emplaced barrier(s). The scope should also address using destructive (i.e., post-test excavation or core sampling) and nondestructive (e.g., geophysical, tracer, or well logging) techniques for evaluating the characteristics of the barrier(s).

Collaboration with an industrial partner is a requirement for this project. The partner should be experienced in installing containment barriers, and should be involved in all phases of the design, construction, and/or installation of the barrier system. Participation by university and other national laboratory experts in reactive material technology and barrier design is strongly encouraged. Cost effectiveness and performance in subcontracting to industry will be considered for this need.

Other Related ID/IPs: VOCs in Arid Soils, Non-VOCs in Non-Arid Soils, Mixed Waste Landfill, Buried Waste, Mixed Waste, Underground Storage Tanks

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Containment of Contaminants through Physical Barriers Formed From Viscous Liquids Emplaced Under Controlled Viscosity Conditions	K. Pruess (LBL) G. Moridis (LBL)	510-486-6732 510-486-4746	R. Scott (SF)
Evaluation of Two New Flowable Grouts	J.L. Rea (SNL)	505-845-8728	P. Saxman (AL)
Hydraulic and Diffusion Barriers in the Vadose Zone Surrounding Buried Waste	J. Heiser (BNL)	516-282-4405	S. Webster

NEEDS STATEMENT: IS-8

ID/IP: In Situ Remediation Integrated Program

Work Breakdown Structure Number : 01.05.01.01.09

Focus Area: High-Level Waste Tank Remediation; Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization; Contaminant Plume Containment and Remediation

Description of Need: Emplacement Technologies for Installing Permeable Reactive Barriers

Goal: Develop and adapt technologies for emplacement and field testing of barriers (1997)

A reactive barrier is an innovative containment technology to prevent the migration of contaminants in a groundwater plume, while allowing water to pass through a treatment barrier. The reactive barrier may be used in conjunction with an impermeable wall when the transverse extent of the plume is broad, in order to direct the contaminated plume toward the reactive barrier that serves as a permeable window through the hydraulic barrier.

A key issue affecting the technical feasibility of reactive barriers is that the reactive material may become exhausted and need periodic replacement. A closely related issue that affects economic feasibility is that an improperly installed reactive barrier will not achieve its design capacity for contaminants and will require more frequent replacement.

The proposed R&D should develop a method and perform pilot-scale (20 to 40 CY tanks) experiments for installing a reactive barrier system with the capability to maintain it. Features to be demonstrated include keying the system into a hydraulic barrier such as a slurry wall; attaining the design hydraulic properties (flow rate vs. hydraulic gradient) and plume cutoff characteristics; and satisfactory recovery of treatment material and replacement with fresh sorbent. The small-scale experiment should use several reactive materials and address the installation of reactive barriers in a number of different soil types and conditions, such as cobbles, stratification or geologic intrusions. The pilot-scale test should be operated for a period of time to sufficiently demonstrate at least one reactive barrier replacement cycle following saturation or near saturation of the barrier. As a minimum, the barrier will be monitored for hydraulic gradient, groundwater velocity, and inlet and outlet groundwater composition for the period of time between each reactive material replacement.

The reactive materials used in the proposed system shall be proven for the target contaminant(s). Reactive materials undergoing laboratory investigation by the In Situ Remediation Integrated Program should be considered as candidate materials, as well those developed in other programs.

The proposed work should also include an optional full-scale system demonstration at a site involving uncontaminated groundwater. A surrogate dissolved chemical species should be used to evaluate the barrier performance using a sorbent tailored to the surrogate species. The sorbent material and surrogate species should simulate the contaminant and reactive materials expected to be demonstrated at the candidate site. The proposed reactive barrier system demonstration should be conducted at a scale sufficient for predicting the performance of a full-scale system. The impermeable walls need to extend from the reactive barrier a distance sufficient to demonstrate keying the reactive barrier system to the impermeable barrier. The materials and methods to be used for constructing the cutoff walls

and installing the reactive barrier system must be amenable to the type of soil/sediment at the candidate demonstration site.

Participation by an industrial partner is a requirement for this project. The partner should be experienced in installing containment barriers, and shall participate in all phases involving the design, construction, and/or installation of the barrier system. Participation by university and other national laboratory experts in reactive material technology and barrier design is strongly encouraged. Cost effectiveness in subcontracting to industry will be considered in evaluating proposed activities for this need.

Other Related ID/IPs: VOCs in Arid Soils, Non-VOCs in Non-Arid Soils, Mixed Waste Landfill, Buried Waste, Mixed Waste, Underground Storage Tanks

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Chemical Barriers Feasibility and Field Demonstration	S. Morrison (GJPO)	303-248-6369	P. Saxman (AL)
Chemically Enhanced Barriers to Minimize Contaminant Migration	K. Cantrell (PNL)	509-376-8647	D. Trader (RL)
Development and Testing of a Water-Permeable Reactive Barrier	D. Janecky (LANL)	505-665-0253	P. Saxman (AL)

NEEDS STATEMENT: IS-9

ID/IP: In Situ Remediation Integrated Program

Work Breakdown Structure Number: 01.05.01.01.09

Focus Area: High-Level Waste Tank Remediation; Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization; Contaminant Plume Containment and Remediation

Description of Need: Integrity Verification of Subsurface Barriers and Performance Monitoring

Goal: Develop and verify technologies to evaluate and test the integrity of subsurface barriers and for monitoring subsequent performance by 1997.

The focus of this need area is to develop and adapt technologies for verifying that emplaced subsurface barriers meet design criteria and then perform as planned over the design lifetime. The verification of integrity of impermeable barriers is extremely challenging when the level of leakage permitted is very low. It may be difficult to measure the integrity of cold joints in certain barrier applications, such as grout barriers. Monitoring the long-term performance of a subsurface barrier is made difficult by the generally large size (up to 5,000,000 ft²) of subsurface barriers.

Techniques and methods for evaluating emplaced subsurface barriers require development and demonstration. The development of subsurface barriers has barely advanced to the field testing phase; thus, there is little information on the quality of joints created between individual segments of subsurface barriers. Moreover, little information exists on the homogeneity of the barrier within segments installed in field tests conducted to date.

Barrier verification technologies must be able to detect the location and measure the magnitude of barrier discontinuities. These barrier discontinuities should be measured to check for conformity with design requirements, e.g., hydraulic conductivity and reaction with contaminants. Researchers must recognize that important discontinuities may exist on a micro-scale (fractions of an inch). Thus, surface geophysical techniques that feature limited spacial resolution are inadequate. The use of tracer gases and liquids for verification testing may be a promising basic approach that requires development and refinement.

Barrier monitoring technologies must enable observations or predictions of loss of barrier performance. Parameters measured must again be related to barrier performance. The proposer shall define the parameters to be measured, describe how they will be analyzed and quantified, and explain how those parameters relate to barrier performance.

The expected outcome of the effort includes development and testing of verification and monitoring techniques in the field. Testing may be conducted in an engineered test bed that facilitates testing of numerous barriers under a variety of simulated conditions.

Participation is required by an industrial partner experienced in containment barrier installation for all phases involving the design, construction, and/or installation of the barrier system. Inclusion of a partner experienced in performance evaluation and integrity verification is highly recommended. Experts in reactive material technology and barrier design from universities and other national laboratories are strongly encouraged to take part. Cost effectiveness in subcontracting to industry will be considered in the evaluation of proposals for this need.

Other Related ID/IPs: VOCs in Arid Soils, Non-VOCs in Non-Arid Soils, Mixed Waste Landfill, Buried Waste, Mixed Waste, Underground Storage Tanks

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Developing/Demonstrating Methods of Placing In Situ Grout Barriers	D. E. Ridenour (FERMCO)	513-738-6772	R. Warner (FN)
Mixed Waste Landfill ID: Barriers and Post-Closure Monitoring	W. Hanson (LANL)	505-667-3331	P. Saxman (AL)
Mixed Waste Landfill ID: Subsurface Barrier Emplacement Development	R. Finley (SNL)	505-844-8351	P. Saxman (AL)

**EFFICIENT SEPARATIONS AND PROCESSING
INTEGRATED PROGRAM**

3.4 The Efficient Separations and Processing Integrated Program (ESPIP)

Mission and Scope of ESPIP

The mission of the Efficient Separations and Processing Integrated Program is to provide appropriate separations technologies (and associated processes) to treat a wide spectrum of radioactive and/or hazardous defense wastes, including high-level wastes (HLW), low-level wastes (LLW), transuranic wastes (TRU), hazardous wastes, and mixed wastes (radioactive and hazardous). ESPIP supports applied R&D leading to demonstration or use of these separations technologies. Pilot demonstration of technologies is the responsibility of other organizations within DOE's Office of Environmental Management.

Targeted Technical Areas

Separations methods are needed to treat essentially all DOE defense wastes. These methods concentrate the contaminants and/or purify waste streams for release to the environment, or for downgrading to a waste form less difficult and expensive to dispose. Initially, ESPIP R&D efforts focused on treatment of HLW from underground storage tanks, because of the potential for large reductions in disposal costs and hazards. As the program has grown, more effort has been directed toward large volumes of other radioactive, hazardous, and mixed waste at DOE facilities. High-level tank waste will remain an important focus for ESPIP R&D.

For more information on this program, please contact:

Teresa Fryberger
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301-903-7688

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Technical Program Coordinator
509-367-0458

NEEDS STATEMENT: ES-1

ID/IP: Efficient Separations and Processing Integrated Program

Work Breakdown Structure Number: 01.05.01.02.04

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

Description of Need: Radionuclide and/or Toxic Component Removal

New and improved separations methods are needed to treat a wide variety of mixed wastes at many DOE facilities. These wastes contain sufficient radioactivity and toxic materials to be handled under provisions of the Atomic Energy Act and the Resource Conservation and Recovery Act. This situation poses regulatory problems. In addition, if the waste or some portion of it is destined for HLW disposal, the presence of certain species in the waste stream may inhibit the formation of a durable glass or may generate a toxic, difficult to handle, off-gas stream. Potential problem species include:

- **Sulfates and Halogens:** Substantial amounts of sulfates can result in liquid phase segregation in the melter, leading to increased volatility of alkali, alkali earth, and radionuclide elements. The molten sulfate salt liquor is corrosive, and can lead to rapid and severe attack of stainless steel and high nickel alloys. Halogens, and in particular chlorides, are volatile, tend to be corrosive, and can produce volatile metal from being contained in the glass. There is a need to remove sulfur and halogens from the incoming waste stream.
- **Volatile Metals:** R&D on high-temperature metal processing in glass melters indicates that glass may not be able to capture a high percentage of the metal contaminants during waste form processing. The percentage of metal that remains in the glass is dependent on factors such as the melter temperature, chloride content, carbon content, metal volatility, presence of a cold cap, and excess air. However, most of the heavy or toxic metals exited with the off-gas or remained in the melter head space deposits. There is a need to remove readily volatilized metals, both radioactive and RCRA regulated, and metals that form volatile oxides from the waste stream. These include Cs, Pb, Hg, Rb, Bi, Cd, Ag, and As.

Separation of radioactive materials from the toxic materials could allow each portion of the waste to be handled under only one set of regulations, thus reducing handling and disposal costs. For example, removal of regulated organics prior to a thermal treatment system may allow the mixed waste stream to be treated as a low-level waste if the organics were the only RCRA regulated materials.

The majority of stored mixed wastes at DOE facilities are solid, but substantial volumes of liquid mixed wastes also exist. For some solids, innovative methods such as selective leaching may be considered for certain wastes. It is important to minimize the secondary wastes produced, to recycle as much of the process reagents as possible, and to concentrate the recovered contaminants for disposal or reuse. More standard adsorption and extraction methods may be adapted for separating components dissolved in waste solutions.

R&D work on mixed wastes must include the use of real wastes from DOE sites and not solely simulants. Solid wastes are particularly difficult to simulate, and experimental results can be highly dependent upon properties of the solids used. For projects targeting melter problems, development of separation processes should be done in parallel with glass, vitrifiers, and off-gas system development, to insure appropriate coordination of requirements and definition of maximum allowable concentrations of problem species in the waste feed and the melt.

Window of Opportunity: FY 95 - 98

Other Applicable IDs/IPs: MWIP, MWLID, Pu in Soils, U in Soils

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Solid Sequestering Agents for the Removal of Transuranics from Radioactive Waste	G. Jarvinen (LANL)	505-665-0822	P. Saxman (AL)
Fission Product Chemistry	M. Attrep (LANL)	505-667-0088	P. Saxman (AL)
Aqueous Biphasic Systems Rad Waste Pretreatment	D. Chaiko (ANL)	708-252-4399	S. Webster (CH)
High Capacity, Highly Selective Sequestrants for Innovative Chemical Separation	D. Wester (PNL)	509-376-4522	D. Trader (RL)
Vacuum Distillation Separation of Plutonium Waste	E. Garcia (LANL)	505-667-0794	P. Saxman (AL)
Removal & Recovery of Toxic Metal Ions/Aqueous Waste Streams	R. Fish (LBL)	510-486-4850	R. Scott (SF)
Derivatives of Natural Complexing Agents for the Removal of Plutonium from Waste Waters	D. Hoffmann (LLNL)	510-423-5031	R. Scott (SF)

NEEDS STATEMENT: ES-2

ID/IP: Efficient Separations and Processing Integrated Program

Work Breakdown Structure Number: 01.05.01.02.04

Focus Area: High-Level Waste Tank Remediation

Description of Need: Sludge Processing

Participants in Hanford's Tri-Party Agreement (TPA), wishing to minimize chemical risks and associated programmatic delays, recently decided to pursue alkaline washing of tank sludge. The suitability of this path will be confirmed by testing sludge washing processes using real waste. Full dissolution of sludge and treatment of the resulting acidic solution is not considered baseline technology of treatment of Hanford tank waste; however, since it remains an important option until alkaline wash is proven, activities on acid side and other treatments will be pursued.

The suitability of the new TPA strategy will depend largely on the volume of the high-level waste (HLW) that would result from vitrification of the sludge. Since the cost of HLW disposal is high, there is an incentive to minimize the fraction of the sludge going to HLW disposal. This leads to two closely related, but opposing goals: (1) to remove from the sludge sufficient amounts of constituents that can be sent to the low-level waste (LLW) form, thus significantly reducing the HLW form volume; or (2) to remove from the sludge sufficient amounts of those constituents that cannot be sent to the LLW form so that the remaining sludge can be disposed of as LLW. The first involves partial removal of abundant nonradioactive constituents, while the second requires dissolution followed by nearly complete removal of dilute radioactive constituents.

To reach either goal, innovative processes are needed that involve minimal technical risk and complexity and do not generate substantial volumes of secondary waste. The process should be efficient (involving minimum addition of process chemicals, particularly any that incinerate into forms other than gases), selective (removing only the needed constituents), and rapid (can be scaled up for practical treatment of millions of gallons of tank waste). For example, it would be desirable to remove bulk constituents, such as aluminum, iron, sodium, etc., from the sludge while requiring minimal separation of HLW constituents from the leachate, in order for it to be disposed of as LLW. That is, constituents such as transuranics, Sr-90, U, etc., would be left in the sludge. There is a particular incentive to remove phosphate from the sludge, because it is sparingly soluble in borosilicate glass and would require production of a large mass of glass if it is not leached from the sludge.

The success of any selective washing or leaching process will depend on the properties of the sludge. Therefore, eventual testing using real sludges will be required, and must be anticipated and defined in proposals for new technologies.

Window of Opportunity: FY 97 for determination of alkaline treatment capability

Other Applicable IDs/IPs: USTID, MWIP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Sludge Washing & Dissolution of ORNL MVST Waste	C. McGinnis (ORNL)	615-576-6845	J. Moore (OR)
Technology Evaluation and Process Definition	L. Lauerhass (PNL) S. Seeman (PNL)	509-376-0458 509-376-1178	D. Trader (RL)
Alkaline Tank Sludge Treatment	R. Quinn (PNL)	509-376-6911	D. Trader (RL)

NEEDS STATEMENT: ES-3

ID/IP: Efficient Separations and Processing Integrated Program

Work Breakdown Structure Number: 01.05.01.02.04

Focus Area: High-Level Waste Tank Remediation; Mixed Waste Characterization, Treatment, and Disposal; Landfill Stabilization

Description of Need: Immobilization and In Situ Treatment

Chemical separation processes involve contacting a waste stream with a separating agent (e.g., sorbent, extractant) in some physical support (e.g., packed bed, immiscible phase) and then physically separating the waste stream from the support, typically by flow. The separated species are left behind in the support and are typically removed so they can be routed to a waste form. However, in at least two cases, it is undesirable to remove the species from the physical support. In the first case, waste can be minimized by converting the physical support (e.g., a packed bed of the separating agent) directly into a waste form that incorporates the separated species. In the second case, the physical support is left in place as part of in situ treatment of groundwater. Sequestering agents developed under ESPIP will be utilized by the ISRIP for the development of in situ technologies to remove and immobilize contaminants from groundwater in situ.

Separation processes are needed that exchange, sorb, or sequester fission products (Cs, Sr, Tc, I, Ni, Sm, etc.) from a variety of waste streams such that the physical support, separating agent, and fission products can be formed directly into a waste form suitable for long-term storage or disposal. The resulting waste form must endure irradiation and chemical changes associated with decay of radionuclides to decay products. Candidate waste streams include:

- acid or alkaline high ionic solutions removed from HLW tanks or resulting from processing of sludge removed from such tanks.
- complexed Sr in high pH supernatant in tank wastes.
- decontamination waste streams.
- miscellaneous aqueous waste or process streams.

Window of Opportunity: FY 95 - 99

Other Applicable IDs/IPs: USTID, MWIP, MWLID, ISRIP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Fission Product Chemistry	M. Attrep (LANL)	505-667-0088	P. Saxman (AL)
Waste Separation and Pretreatment Using Titanate Ion Exchangers	N. E. Brown (SNL)	505-845-8180	P. Saxman (AL)
High-Capacity, Highly Selective Sequestrants for Innovative Chemical Separation	D. Wester (PNL)	509-376-4522	D. Trader (RL)

NEEDS STATEMENT: ES-4**ID/IP: Efficient Separations and Processing Integrated Program****Work Breakdown Structure Number: 01.05.01.02.04****Focus Area: Contaminant Plume Containment and Remediation****Description of Need: Soils and Groundwater Treatment**

Separation methods are needed to remove contaminants selectively and efficiently from groundwater and soils. Treated water must meet appropriate regulations for residual contaminant concentrations, and the separation method needs to remove as little additional (non-contaminant) materials as possible. To minimize waste generation, it is desirable to concentrate the toxic and/or radioactive contaminant so it can be incorporated in as small a waste volume as possible. Removal of additional non-contaminants will dilute the final waste form and result in greater waste volumes. When it is possible to recycle the contaminants, highly selective removal provides a more nearly pure "product" (less additional material mixed with the material removed) for recycle. Selective adsorbents or extractants with high capacity, good mass transfer rates and/or kinetics, and high selectivity could be used ex situ for treating groundwaters pumped from aquifers. Such adsorbents may find applications in situ as "adsorptive barriers," which prevent underground transport of radioactive and toxic contaminants.

Even moderately small quantities of highly toxic contaminants with low solubilities in water can contaminate very large groundwater plumes. Many groundwater plumes result from contaminants that are concentrated in soils. In many cases, the most practical approach, and often the only permanent solution to ending problems with contaminated plumes, is to remove the source. That source can be contaminated soils. Volatile contaminants are commonly vaporized from contaminated soils, using either in situ or ex situ operations. However, most radioactive and toxic metal contaminant (except for mercury) cannot be removed by simply flushing the soil with air and/or heating the soils to moderately high temperatures. In those cases, selective leaching approaches are needed.

It is desirable to have a highly selective leach process that does not remove large portions of the soil other than the contaminants. Removal of other excessive materials will result in larger waste volumes, and could produce a highly degraded "clean" soil that will not support plant life and has little or no future economic use. Since leach processes should not produce excessive wastes, it is desirable to maximize the recycle of leach liquor. This may involve recovery of the contaminants from the leach liquor so that all or most of the liquor can be recycled for further leaching. It may involve minimizing "consumption" of leaching reagents by reaction with non-toxic components that do not need to be removed from the soil. There are a wide variety of both radioactive, toxic, and heavy metal contaminants in the groundwaters and soils at DOE facilities. Some of the most common are uranium, technetium, trichloroethylene, and PCBs.

Other Applicable IDs/IPs: ISRIP, MWIP, Pu in Soils, U in Soils, VOCs in Arid Soils, VOCs in Non-Arid Soils

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Solid Sequestering Agents for the Removal of Transuranics from Radioactive Waste	G. Jarvinen (LANL)	505-665-0822	P. Saxman (AL)
Fission Product Chemistry	M. Attrep (LANL)	505-667-0088	P. Saxman (AL)
Waste Separation and Pretreatment Using Titanate Ion Exchangers	N. E. Brown (LANL)	505-845-8180	P. Saxman (AL)
Aqueous Biphasic Systems/ RAD Waste Pretreatment	D. Chaiko (CH)	708-252-4399	S. Webster (CH)
High-Capacity, Highly Selective Sequestrants for Innovative Chemical Separation	D. Wester (PNL)	509-376-4522	D. Trader (RL)
Removal & Recovery of Toxic Metal Ions/Aqueous Waste Streams	R. Fish (LBL)	510-486-4850	R. Scott (SF)
Derivatives of Natural Complexing Agents for the Removal of Plutonium from Waste Waters	D. Hoffmann (LLNL)	510-423-5031	R. Scott (SF)

NEEDS STATEMENT: ES-5

ID/IP: Efficient Separations and Processing Integrated Program

Work Breakdown Structure Number: 01.05.01.02.04

Focus Area: Facility Transitioning, Decommissioning, and Final Disposition

Description of Need: Aqueous Processing

The need to decontaminate and decommission DOE facilities is growing. New separation methods are needed for leaching material from surfaces, recovering and concentrating radioactive and toxic materials removed in decontamination, and removing the toxic and/or radioactive materials so decontaminating fluids can be reused. When regulations permit, it will also be desirable to purify metals and other materials from decommissioned facilities sufficiently that these materials can be released and sold for use in the marketplace. ESPIP's role in decontamination focuses on minimizing the potentially huge volume of D&D wastes. It is anticipated that many technologies developed for HLW by ESPIP could be modified to meet this requirement.

Selective leaching processes are also needed to remove contaminants from contaminated metals and structural materials at DOE facilities. Leaching methods must be efficient (remove a sufficient fraction of the material from the solid), selective (not remove too much inert or additional material from the solid), and rapid. Furthermore, methods are needed to remove contaminants from the leach liquors, usually for disposal in small volumes. It is desirable to recycle as much of the leach liquor as possible, and minimize the wastes generated in the process. The contaminants on equipment and structural surfaces at DOE facilities include essentially all radioactive elements, common solvents such as TCE and PCBs, and a few toxic metals - in particular, mercury.

Decontamination methods need to be developed for use with specific materials and contaminants found at DOE facilities. Although good characterization studies can allow some materials and their surfaces to be simulated, all R&D needs to aim at testing leach procedures with actual materials from a specific DOE problem. Investigation of methods for recovering contaminants from decontamination solutions must be directed at a specific solutions that have a significant chance for being adopted for D&D of specific DOE facilities. Such studies are particularly important when the ability to concentrate the contaminants and recycle the leach liquors is an important consideration in adoption of that decontamination approach.

Other Applicable IDs/IPs: MWIP, D&DID

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Solid Sequestering Agents for the Removal of Transuranics from Radioactive Waste	G. Jarvinen (LANL)	505-665-0822	P. Saxman (AL)
Fission Product Chemistry	M. Attrep (LANL)	505-667-0088	P. Saxman (AL)
Waste Separation and Pretreatment Using Titanate Ion Exchangers	N. E. Brown (SNL)	505-845-8180	P. Saxman (AL)
Magnetically Assisted Chemical Separations	L. Nunez (ANL)	708-252-3069	S. Webster (CH)
High-Capacity, Highly Selective Sequestrants for Innovative Chemical Separation	D. Wester (PNL)	509-376-4522	D. Trader (RL)
Removal & Recovery of Toxic Metal Ions/ Aqueous Waste Streams	R. Fish (LBL)	510-486-4850	R. Scott (SF)
Derivatives of Natural Complexing Agents for the Removal of Plutonium from Waste Waters	D. Hoffmann (LLNL)	510-423-5031	R. Scott (SF)

NEEDS STATEMENT: ES-6

ID/IP: Efficient Separations and Processing Integrated Program

Work Breakdown Structure Number: 01.05.01.02.04

Focus Area: High-Level Waste Tank Remediation

Description of Need: Transuranic Element Removal

There is a need to remove transuranic elements and other selected components from high-level wastes (HLW) in underground storage tanks at Hanford and other DOE sites. This would allow concentration of those components into a minimum volume of HLW for ultimate disposal in a geologic repository. Present plans include incorporation of the HLW into borosilicate glass that will be sent to the repository. This is expected to be the most costly waste form per unit volume for tank wastes. Concentration of materials that must go to the HLW repository could have important cost benefits. Sufficient separation of these components would allow the remaining materials to be incorporated in a low-level waste form, which would be less costly and conserve space in the repository.

Transuranium elements may need to be removed from the alkaline supernates from some of the tanks to permit these materials to be incorporated in LLW. Sludges (solid precipitates) in HLW storage tanks are also expected to be washed or leached to remove selected materials, and the washing or leaching may dissolve sufficient transuranium materials that the liquors would be unacceptable for incorporation in a LLW. It would then be necessary to remove the transuranium components from the leach liquor so it can be returned to the HLW. The potential need for removal of transuranium materials from leach liquors may depend upon how "aggressive" the leach step will have to be to remove sufficient fractions of other materials that hinder formation of borosilicate glass.

Optional approaches to minimizing the HLW produced by alkaline sludge treatment include actual acid dissolution of the sludge, followed by a series of separation steps to separate and concentrate the components that need to be incorporated in the HLW from those that can go to the LLW forms. Since dissolution is likely to involve use of nitric acid, separation methods for removing transuranium elements from dissolution liquors would need to operate with acid solutions.

It is important that R&D on transuranium separations be related to a potential scenario or flowsheet that could be used with HLW in DOE storage tanks. This means that proposed work needs to include pH and compositions of solution that exist or could result from processing of material in DOE tanks.

Transuranic (TRU) elements exist in many DOE wastes. These include:

- sludges precipitated from alkaline tank wastes, either acid or alkaline solutions formed by leaching or dissolving tank sludges, and complexed TRU species in high pH supernatant in tank wastes.
- decontamination waste streams.
- solid wastes, including mixed waste and buried waste.

- miscellaneous aqueous waste or process streams.

Consequently, innovative methods are needed that remove:

- TRU elements from acid streams (e.g. 1M HNO₃); new processes should surpass existing solvent extraction processes.
- TRU elements from high ionic strength (up to 10M) alkaline (pH up to 14) streams, including complexed species.
- very small concentration of TRU elements from waste waters and process streams.
- TRU elements from solid wastes.

In all cases, methods are needed that:

- are efficient (remove virtually all TRU elements from waste and release virtually all TRU elements to effluent streams), selective (do not remove transition metals, ideally do not remove lanthanides, etc.), and rapid (can be implemented at an industrial scale).
- generate minimal secondary wastes and do not require challenging separations to further treat effluent streams.
- are economical (especially for treatment of waste water and miscellaneous waste streams) and are simple to maintain and operate.

Other Applicable IDs/IPs: USTID, MWIP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Fission Product Chemistry	M. Attrep (LANL)	505-667-0088	P. Saxman (AL)
Solid Sequestering Agents for the Removal of Transuranics from Radioactive Waste	G. Jarvinen (LANL)	505-665-0822	P. Saxman (AL)
Vacuum Distillation Separation of Plutonium Waste	E. Garcia (LANL)	505-667-0794	P. Saxman (AL)
Russian Separations Work	J. Rea (SNL)	505-845-8728	P. Saxman (AL)
Magnetically Assisted Chemical Separations	L. Nunez (ANL)	708-252-3069	S. Webster (CH)
Advanced Processing for Clean Option	P. Horwitz (ANL)	708-252-3653	S. Webster (CH)

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Aqueous Biphasic Systems/ RAD Waste Pretreatment	D. Chaiko (ANL)	708-252-4399	S. Webster (CH)
Pyrochemical Treatment and Immobilization of Idaho Chemical Processing Plant High-Level Waste Calcine	T. A. Todd (INEL)	208-526-3365	T. Williams (ID)
Technology Evaluation and Process Definition	L. Lauerhass (PNL) S. Seeman (PNL)	509-376-0458 509-376-1178	D. Trader (RL)
Calcine Residue Leaching	G. Culley (PNL)	509-376-5655	D. Trader (RL)
Removal & Recovery of Toxic Metal Ions/ Aqueous Waste Streams	R. Fish (LBL)	510-486-4850	R. Scott (SF)
Derivatives of Natural Complexing Agents for the Removal of Plutonium from Waste Waters	D. Hoffmann (LLNL)	510-423-5031	R. Scott (SF)

NEEDS STATEMENT: ES-7**ID/IP: Efficient Separations and Processing Integrated Program****Work Breakdown Structure Number: 01.05.01.02.04****Focus Area: High-Level Waste Tank Remediation****Description of Need: Fission Product Removal**

Optimum treatment of high-level wastes in storage tanks at DOE facilities will require separation of several fission products. Cesium, strontium, and relatively short-life fission products are responsible for the largest fraction of the heat generated in HLW storage tanks. These components are also responsible for gamma radiation that creates the need to use extensive shielding and remote operations when handling the wastes. Removal of these elements would decrease the difficulties and hazard of handling or treating these materials. Removal of these materials from the liquid supernate in many tanks would allow remaining materials to be treated as low-level waste, so disposal would be both less costly and less hazardous. Small quantities of these elements may occur in wash or leach liquors from washing or leaching of the solid precipitates (sludges) in the tanks. These are also likely to be alkaline solutions with high sodium concentrations. If the tank solids (sludges) are dissolved for more extensive separation and concentration of the various sludge components, traces of cesium, and, especially, strontium may need to be separated from the other dissolved components of the sludge. Such separations are likely to be from acid solutions.

Selected long-lived components must be separated waste components that need to be sent to LLW. Technetium is the most notable example. This element can exist in different valence forms, is often distributed to different streams during waste processing, and has a high mobility from many waste forms.

R&D on fission product separations must address conditions that exist in DOE tank wastes or could result during treatment of those wastes. This may involve highly alkaline and high sodium content supernates or wash/leach liquors, as well as acid solutions that would result from possible dissolution of the solid sludges. In evaluating any selective separation agent, it is important to test the methods in the presence of all potential competing components. This is especially important when the target components, such as fission products, exist at only trace concentration levels, but other elements that can behave similarly are present at much higher concentrations. Removal methods need to be highly specific for target components and must remove them in a concentrated form.

Other Applicable IDs/IPs: USTID, MWIP

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Fission Product Chemistry	M. Attrep (LANL)	505-667-0088	P. Saxman (AL)
Russian Separations Work	J. Rea (SNL)	505-845-8728	P. Saxman (AL)
Waste Separation and Pretreatment Using Titanate Ion Exchangers	N. E. Brown (SNL)	505-845-8180	P. Saxman (AL)
Advanced Processing for Clean Option	P. Horwitz (ANL)	708-252-3653	S. Webster (CH)
Aqueous Biphasic Systems RAD Waste Pretreatment	D. Chaiko (ANL)	708-252-4399	S. Webster (CH)
Sludge Washing & Dissolution of ORNL MVST Waste - Technetium Extraction	B. Moyer (ORNL)	615-574-6718	J. Moore (OR)
High-Capacity, Highly Selective Sequestrants for Innovative Chemical Separation	D. Wester (PNL)	509-376-4522	D. Trader (RL)
Technology Evaluation and Process Definition	L. Lauerhass (PNL) S. Seeman (PNL)	509-376-0458 509-376-1178	D. Trader (RL)

NEEDS STATEMENT: ES-8

ID/IP: Efficient Separations and Processing Integrated Program

Work Breakdown Structure Number: 01.05.01.02.04

Focus Area: Contaminant Plume Containment and Remediation

Description of Need: Tritium Removal

Tritium removal from both wastewaters and groundwaters presents particularly difficult problems. To remove tritium from water, an isotope separation process is needed. There are no highly specific adsorbents for tritium or tritiated water, and the separation factors available are sufficiently low that many separation stages are needed. Although the separation factors for separation of hydrogen isotopes are among the highest available for any isotope separation, they are still low compared to those often available for removing most other inorganic components from wastes or groundwater. This makes the capital and operating costs for high throughput systems very high; most isotope separation systems operate with much lower throughputs than those often needed for treating major wastes and groundwater flows.

Innovative hydrogen isotope separation methods are needed to extend the range of conditions for which it is practical to treat wastes for tritium removal. Since several methods have been developed and used in the past, it is necessary that any R&D on tritium removal be sufficiently innovative and potentially better than the methods available presently. The current "standard" technology may be the hydrophobic water-hydrogen catalytic process being employed by the Canadian nuclear program for removing tritium from heavy water coolant in their reactors. This would be a suitable standard for comparing any new tritium separation concept. Although there would be some merit in using the waste or groundwater in its existing form as feed to a tritium separation system, special feed preparation such as demineralization, evaporation, or even electrolysis may be needed.

Other Applicable IDs/IPs: ISRIP, MWIP, Innovative Technologies

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Separation of HTO Using Membranes	D. Nelson (PNL)	509-376-0875	D. Trader (RL)
Aqueous Phase Catalytic Exchange Detritiation of Waste	A. Birchenall (WSRC)	803-644-5030	M. O'Rear (SR)

NEEDS STATEMENT: ES-9**ID/IP: Efficient Separations and Processing Integrated Program****Work Breakdown Structure Number: 01.05.01.02.04****Focus Area: High-Level Waste Tank Remediation; Mixed Waste Characterization, Treatment, and Disposal****Description of Need: Organic and/or Nitrate/Nitrite Destruction and/or Separation**

Nitrates and nitrites constitute the largest fraction of wastes at some DOE sites, and these components can increase the volume requirements for disposal and/or storage. Nitrates and organic compounds complicate waste processing and are not easily incorporated into some waste forms; they can even increase the leaching of other components from waste forms. Organic compounds can include solvents that act as ligands for some metals or radioactive components of the waste, and reduce the effectiveness of some methods for removing those metals from the waste.

New and improved methods are needed to destroy nitrates and/or selected organic compounds. The methods should have significant potential advantages over current technologies. For instance, improved methods would operate on solid as well as liquid wastes, would be suitable for liquids with high concentrations of solids, would more easily operate in highly radioactive environments, or could offer greater safety or robustness for a variety of wastes. Where nitrates can be used (such as sodium nitrate or nitric acid) or where organic compounds can be recycled, effective recovery methods will have advantages over destruction methods. Most current approaches involve destruction of these materials. It is important to direct the R&D focus toward a current, specific DOE problem. Investigators must be prepared to conduct some or most of the tests with actual DOE wastes.

Other Applicable IDs/IPs: MWIP, MWLID**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Development & Evaluation of Electrochemical of Destroying Nitrates and Nitrites in HLW and LLW	D. Hobbs (WSRC)	803-725-2838	M. O'Rear (SR)
Significant Volume Reduction of Tank Waste by Selective Crystallization of Sodium Nitrate as a Clean Salt	D. Hering (PNL)	509-373-2532	D. Trader (RL)
NaNO ₃ Separation from Tank Farm Wastes by Freeze Crystallization	R. Boardman (INEL)	208-526-3732	T. Williams (ID)

SECTION 4.0
OTHER PROGRAMS

MINIMUM ADDITIVE WASTE STABILIZATION PROGRAM

4.1 Minimum Additive Waste Stabilization Program (MAWS)

The Minimum Additive Waste Stabilization Program was established in 1991 as a DOE Office of Technology Development feasibility study. The program uses mixed wastes requiring remediation as resources for vitrification to produce a stable and durable glass or slag final waste form for disposal. The place chosen for initial demonstration was a Fernald CERCLA site (OU-1, Pit 5) containing sludges, soils, and various other wastes amenable to vitrification. Initial success of high-waste loading at Fernald has indicated that vitrification may be a cost-effective treatment for large volumes of mixed wastes, which can be pursued for other DOE complex waste streams.

In the MAWS concept, waste streams are viewed as resources since they contain the basic components from which a glass or glassy slag can be made. The challenge is to combine these resources in such a way that minimizes the use of non-waste additives, yet yields a processable and durable final waste form for disposal. The benefit to this approach is that the volume of the final waste form is minimized (waste loading is maximized) since little or no additives are used. Vitrification itself results in volume reduction through evaporation of water, combustion of organics, and compaction of the solids into a non-porous glass. This implies a significant reduction in disposal costs due to volume reduction alone, and minimizes future risks/costs due to the long-term durability and leach resistance of glass and slags.

This is accomplished by using integrated systems that are both cost effective and produce an environmentally sound waste form for disposal. Individual component technologies may include vitrification, thermal destruction, soil washing, gas scrubbing/filtration, and ion exchange waste water treatment. The particular combination of technologies will depend on the waste streams to be treated. At the heart of the MAWS program is vitrification technology, which incorporates all primary and secondary waste streams into a final, long-term, stabilized glass waste form.

In the Fernald application, an integrated technology system was utilized to determine the feasibility of remediating multiple waste streams. The system included a joule heated melter (approximately 1100C) complete with off-gas system, a soil washing system, and an ion exchange waste water treatment system. The study was conducted using a systems approach where mixed waste sludge contaminated with U and RCRA metals, soil contaminated with U, and wastewater contaminated with U from soil washing were inputs to the treatment system. Durable glass, clean soil, clean water, and clean off-gas were outputs.

Laboratory crucible studies achieved high-waste loading (up to 90% on a wet basis) while producing quality glass (i.e. passes Toxicity Concentrate Leachate Procedure (TCLP) and compares favorably to the high-level waste glass Product Consistency Test (PCT) test standards). A radioactive, continuous bench-scale melter test was successfully completed (10 kg/day and 100 kg/day glass production rate), which produced similar quality glass and off-gas meeting specified standards. The pilot-scale system, which includes a 300 kg/day glass production melter, a 0.25 ton/day soil washing system, and a 100 gallons per minute (GPM) ion exchange waste water treatment system for radioactive testing is currently on-site at Fernald. Testing was initiated in September 1993. Preliminary analyses indicate an estimated total life-cycle cost savings of \$720M for the 8 pit wastes at Fernald, when comparing the MAWS vitrification approach to cementation.

Program Scope/Activities

Implementation of MAWS includes the following elements:

- *Compositional Envelope Studies* - These studies will identify feasible waste stream blends based on crucible melts. The crucible melts are not thermal process-specific, but are intended to focus on the chemistry involved in incorporating waste into a quality, durable final waste form.

On-going activities: Crucible melt studies using actual radioactive wastes from selected DOE sites will determine the feasibility of the MAWS concept. This activity is expected to continue into FY 95 and beyond, based on site needs and outcome of crucible melts. Two activities include compositional development for glass where glass formers and fluxes are present, and compositional development for glassy/slag (higher metal content waste).

- *Technology Development* - Technology candidates will be identified based on waste needs and preliminary crucible studies. High temperature melter technologies will be investigated for wastes that have different processing requirements than wastes at Fernald. Potential industry/university and National Laboratory participants will be identified for participation in technology testing/development.

On-going activities: Preliminary tests were completed in FY 93 using plasma technology to determine feasibility of creating a quality waste form by combining high percentages of metal with soil. The resulting waste form is currently being evaluated using TCLP and PCT tests.

- *Final Waste Form Analysis* - Final waste forms will be evaluated using various leachability and durability tests. Modeling will be used to predict behavior.

On-going activities: TCLP and PCT tests are underway to evaluate waste forms from Fernald, as well as from the plasma testing. A vapor phase test is being used to further study characteristics/durability of the Fernald glass.

- *Cost* - total life-cycle cost will be calculated and compared to other treatment alternatives.

On-going activities: Only preliminary cost calculations have been completed to date for the Fernald demonstration. More detailed calculations are planned for FY 94 pending approval of FY 94 budget.

A site demonstration is planned for FY 95, which will require identification and selection of an appropriate site(s). This will include assessment of site waste needs and regulatory commitment/urgency.

MAWS Objectives

- Develop and implement vitrification technology systems that are viable and affordable (life-cycle cost) to remediate multiple waste streams.

- **Employ technology systems that will be a combination of existing equipment if appropriate, or develop new technologies if needed, in order to achieve the widest application of MAWS.**
- **View waste streams as vitrification resources to minimize additives for vitrification.**
- **Employ technologies to accomplish effective treatment of the primary waste, such as destruction of organics and encapsulation of radioactive and inorganic constituents (such as toxic metals).**
- **Implement technologies to result in enhanced waste forms that will stand up to the most rigorous set of standards that exist/will be developed for quality and durability.**
- **Produce an enhanced waste form and address secondary wastes including minimization where possible, recycling, and identifying or providing treatment solutions acceptable for storage and/or disposal.**
- **Minimize total volume (enhanced final waste and secondary wastes) for disposal.**
- **Involve industry/universities as much as possible in technology development to promote technology commercialization and produce competitive, cost-effective solutions.**
- **Develop technologies using a staged approach. Use testing data to establish site demonstrations and eventually develop and operate full-scale treatment. Prove processes acceptable for transfer to the end-user to facilitate and accelerate waste treatment/remediation.**

NEEDS STATEMENT: MA-1

ID/IP: Minimum Additive Waste Stabilization Program

Work Breakdown Structure Number: GS21

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

Description of Need: Treatment systems for the following vitrification technologies, both laboratory and pilot scale, are needed to verify compositional studies in operational systems, preferably capable of radioactive mixed waste testing, but surrogates testing will also be considered:

- Microwave technology.
- Plasma technology.
- High-temperature joule heated melting.
- Other high-temperature systems for production of enhanced waste forms.

The treatments should be able to meet as many objectives as possible while operating in both oxidizing and reducing modes. Off-gas sampling and analysis will be required. Level of effort will be dependent on outcome of high-temperature vitrification development/testing work being completed in FY 94; however, all types and scales of the above technologies should be proposed for inclusion. Those that require the least amount of development work are preferable (demonstrated technology, existing equipment and facility for testing), but others will be considered if they may deliver significant improvements over existing technology when developed.

Waste feed materials may include sludges, soils, asbestos, and/or debris (metal and non-metal), wastes typical of a site requiring cleanup. Waste feed capabilities of the system must be appropriate to handle a variety of wastes, either through pretreatment or direct feed. The types of contaminants may include organics, toxic metals, and radionuclides. Typically, the wastes to be addressed are low-level mixed wastes, but may also contain small amounts of TRU radionuclides (< 100 nanocuries per gram).

Window of Opportunity: FY 95 - 2000

Other Applicable IDs/IPs: Mixed Waste Integrated Program

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Compositional Envelope	I. Pegg (CUA)	202-319-6700	S. Webster (CH)
High-Temperature Vitrification	I. Pegg (CUA)	202-319-6700	S. Webster (CH)
MAWS at Fernald	I. Pegg (CUA)	202-319-6700	S. Webster (CH)

NEEDS STATEMENT: MA-2

ID/IP: Minimum Additive Waste Stabilization Program

Work Breakdown Structure Number: GS21

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

Description of Need: Off-gas system operation/optimization:

- Technologies for separation of problem contaminants (particulates, salts, radionuclides) in off-gas system to facilitate secondary waste treatment.
- Recycle of off-gas and resulting wastes.
- Minimized off-gas and volatility of toxic metals and radionuclides.

The above needs are expected to be addressed simultaneously with development of the vitrification processes (systems approach).

Based on compositional development studies completed in FY 94, testing will be conducted in selected high- temperature systems to determine segregation of waste constituents, particularly toxic metals and radionuclides between waste form and secondary streams.

Window of Opportunity: FY 95 - 2000

Other Applicable IDs/IPs: Mixed Waste Integrated Program

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
MAWS at Fernald	I. Pegg (CUA)	202-319-6700	S. Webster (CH)

NEEDS STATEMENT: MA-3

ID/IP: Minimum Additive Waste Stabilization Program

Work Breakdown Structure Number: GS21

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

Description of Need: Waste pretreatment technologies (if primary technologies do not address):

- High-activity tank wastes (separation).
- High organics/combustibles (incineration or other).
- Low solids (incineration).
- High metals (separation/cleaning).
- High mercury content (separation/recovery).

These may include various separation and/or incineration unit operations where the outputs are suitable for feed to the melter or can be readily disposed or recycled. These systems will be implemented simultaneously with vitrification and off-gas equipment chosen for inclusion into the MAWS Program.

Window of Opportunity: FY 95 - 2000

Other Applicable IDs/IPs: Mixed Waste Integrated Program

Currently Related Tasks: None

NEEDS STATEMENT: MA-4

ID/IP: Minimum Additive Waste Stabilization Program

Work Breakdown Structure Number: GS21

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

Description of Need: Demonstration site selection is needed, including:

- Site needs including specification of waste types, planned technology activities.
- Regulatory commitments-ROD dates or other regulatory imposed dates.
- Waste stream data (chemical and radionuclide, volume).
- Management and technical team for site demo.
- Anticipated stakeholder involvement and reception of demonstration effort.

Based on response to needs statement as well as other data gathered on site needs, a demonstration site will be selected and is planned for initiation in FY 95.

Window of Opportunity: FY 94 - 95

Other Applicable IDs/IPs: None

Currently Related Tasks: None

NEEDS STATEMENT: MA-5

ID/IP: Minimum Additive Waste Stabilization Program

Work Breakdown Structure Number: GS21

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

Description of Need: Life-cycle cost and system scale-up analysis. There is a need for system/computer modeling that would allow for simulation of technical operation, and calculate resulting life-cycle cost. These systems/programs should be easily adaptable to specific technology applications employed in MAWS. Such modeling would be useful in evaluating capabilities of the system:

- Based on preliminary data, design and size system scale-up units.
- Use to optimize system (temperature, pressure, feed rate, off-gas treatment and recycle, etc).
- Use to calculate life-cycle costs.

Window of Opportunity: FY 94 - 2000

Other Applicable IDs/IPs: All

Currently Related Tasks: None

NEEDS STATEMENT: MA-6

ID/IP: Minimum Additive Waste Stabilization Program

Work Breakdown Structure Number: GS21

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

Description of Need: Quality assurance/independent verification of compositional model for predicting durability. Modeling information developed in the compositional envelope task may require some quality verification. The level of verification will depend on intended use of the information, which has not been expressly determined at this time.

Window of Opportunity: FY 95 - 2000

Other Applicable IDs/IPs: Mixed Waste Integrated Program

Currently Related Tasks: None

NEEDS STATEMENT: MA-7

ID/IP: Minimum Additive Waste Stabilization Program

Work Breakdown Structure Number: GS21

Focus Area: Mixed Waste Characterization, Treatment, and Disposal

Description of Need: Improvements/development for:

- Electrode durability and life.
- Redox measurement in the melt.
- Hot-gas sampling and analysis.

Window of Opportunity: FY 95 - TBD

Other Applicable IDs/IPs: MWIP, CMST-IP

Currently Related Tasks: None

SUPERCritical WATER OXIDATION PROGRAM

4.2 Supercritical Water Oxidation Program

SCWO Program Mission

The Supercritical Water Oxidation (SCWO) program aims to develop a viable supercritical water oxidation technology for the treatment of hazardous and mixed radioactive waste.

SCWO Program Approach

The program will make maximum use of currently available SCWO information from pilot plant test projects, focus research and development on essential technology improvements, and seek to minimize costs. To accomplish this strategy, the program will consist of three projects, several technical review groups, and private industry participation.

1. **Hazardous Waste Pilot Plant (HWPP) Demonstration** - This demonstration will identify technology needs and demonstrate currently available SCWO technology for processing hazardous waste and surrogate radioactive waste of interest to DOE. The HWPP will be designed and constructed by private industry, thereby incorporating the latest private industry technology into the project. Any technology development needs identified by the program participants during design, design reviews, construction operation, or data evaluation will be provided to the SCWO Research and Development (R&D) manager and incorporated into the SCWO R&D Project Plan.
2. **SCWO R&D** - This project will seek technology improvements required to demonstrate that SCWO is a safe, cost-effective technology for processing mixed waste. SCWO R&D tasks will emanate from the HWPP and mixed waste pilot plant (MWPP) demonstration projects. Only technology development that directly supports the demonstration projects will be included in the SCWO R&D project. Technical support groups (TSGs) will provide recommendations to the SCWO R&D project and demonstration projects, but only those tasks endorsed by the demonstration projects will be pursued.
3. **Mixed Waste Pilot Plant (MWPP) Demonstration** - This activity will demonstrate improvements and new technology from the first two projects. It will include the design, construction, operation, data collection, and data evaluation of the MWPP. This plant will be capable of at least 500 gal/day of liquid waste throughput. It will be used to demonstrate that SCWO technology can safely and effectively treating applicable DOE mixed waste.

Supercritical Water Oxidation

This technology holds promise for treating a portion of DOE mixed waste. Unlike incineration, SCWO can easily be designed as a full containment process with no release to the atmosphere. SCWO can achieve the high destruction efficiencies for hazardous wastes such as polychlorinated biphenyls (PCBs) or dioxins. In comparison to plasma treatment methods and incineration, SCWO processes achieve high organic destruction efficiencies at much lower temperatures and without NO_x production. When contrasted to many thermal treatment technologies, SCWO can process wastes with low concentrations of organics. SCWO has potential permitting advantages over other waste destruction technologies, because EPA has determined that SCWO is appropriately classified as a treatment facility, rather than as an incinerator or a thermal treatment process.

In the SCWO process, a waste containing an oxidizable component is brought together in water with an oxidizer at conditions above the critical temperature (374°C) and critical pressure (22 MPa) of water. At these conditions, the reaction mixture is a single phase, resulting in rapid reaction rates, not limited by diffusion across phase boundaries. The solvent properties of supercritical water are different from those of liquid water; nonpolar compounds become soluble, and salts become insoluble. Thus organic wastes are highly soluble at supercritical conditions, promoting fast reactions, while inorganic salts tend to precipitate, facilitating separation of reaction products.

Technology Development Opportunities

Technology development opportunities exist in support of the SCWO program. The specific needs identified in document are viewed as either technological improvements required for mixed waste demonstration of SCWO technology, or fundamental knowledge required to safely operate SCWO systems. Research and development activities should be demonstrated on laboratory or bench scale systems. All proposed technologies should be scheduled for deployment into the HWPP or MWPP.

Collaboration is a valuable component of any proposed activities through the SCWO program. Proposed activities should include participants from the private sector and universities, when appropriate.

The SCWO Program requests interested investigators to submit for review full length preliminary Technical Task Plans, in accordance with the EM-50-FY 94 Guidance and Format, proposing technological solutions for the identified needs of FY 95. Each proposed technology will be evaluated relative to the following set of criteria:

- **Technical Approach** - Clearly state the intended approach and, specifically, how it will be conducted. The approach should be technically sound, provide for decision points, and provide a methodology that will ensure the intended results will be achieved. The proposal should be based on scientifically sound principals. The principles investigator should demonstrate an understanding of the fundamentals of the proposed technology. Background information should show that the PI has an understanding of the literature and on-going past, present, and associated work.
- **Schedule** - The proposed schedule should provide a logical sequence of activities. Proposals must support the overall SCWO program schedule, and should provide for testing of the technology on one of the two SCWO pilot plants. Appropriate milestones should be identified. Several milestones should be identified throughout the fiscal year, so that on-going progress can be evaluated.
- **Deliverables** - Deliverables should be identified that will provide the SCWO Program with the information required to determine the status, performance, and whether continued activities are warranted.

SCWO Program Points of Contact:

Jaffer Mohiuddin
DOE-Headquarters
(301) 903-7965

Kevin Price
DOE-Idaho
(208) 526-5192

John Beller
Technical Program Coordinator
(208) 526-1205

NEEDS STATEMENT: SC-1**ID/IP: Supercritical Water Oxidation Program****Work Breakdown Structure Number: 01.05.01.02.09****Focus Area:****Description of Need: Correlation Between Surrogates and Radionuclides**

Testing performed by the SCWO program has been conducted using surrogates in place of actual radionuclides. These surrogates are anticipated to be used in future testing of the HWPP, because they provide important information without the constraints associated with mixed waste processing. There is limited research on how these surrogates, under SCWO conditions, correlate to the radionuclides they represent. Research is requested on radionuclides of concern under SCWO conditions to understand their chemical and physical interactions, solubility, volatility, etc. Further information on the surrogates to be used and the radionuclides they represent can be found in the report *Mixed Waste Survey for the Supercritical Water Oxidation Program*, EG&G-WTD-10984, September 1993.

Window of Opportunity: Initial correlations should be complete by the middle of FY-96 to support testing on the HWPP and design efforts for the MWPP.

Other Applicable IDs/IPs: Mixed Waste Integrated Demonstration**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Mixed Waste Survey	C. Barnes (INEL)	208-526-0864	T. Williams (ID)

NEEDS STATEMENT: SC-2**ID/IP: Supercritical Water Oxidation Program****Work Breakdown Structure Number: 01.05.01.02.09****Focus Area:****Description of Need: Salt Separation/Dehalogenation**

Many DOE wastes contain components that will deposit or form corrosive species if processed in a SCWO system. The program seeks to demonstrate low-cost, effective pretreatment schemes to remove or destroy these species. Wastes being considered for demonstration testing include; 100% TRIM-SOL, PCB-contaminated mixtures of oils such as ethylene glycol, ethanolamines, and motor oil; a "combustible solids" waste containing paper, cloth, and plastics including PVC; spent activated carbon loaded with chlorinated hydrocarbons, a halogenated solvent waste containing carbon tetrachloride, TCE, and freon; and an organic sludge containing 30% calcium silicate plus a mixture of oils and chlorinated solvents. Testing needs to demonstrate the ability to remove organic halogens, sulfur, and phosphorus to a level of 100 ppm and the removal of nonoxidizable solids to about 400 ppm. Specific information on the wastes to be tested can be found in the report *Mixed Waste Survey for the Supercritical Water Oxidation Program*, EG&G-WTD-10984, September 1993.

Window of Opportunity: Technologies must be demonstrated on bench scale by the middle of FY 96 to support testing on the HWPP and design efforts for the MWPP.

Other Applicable IDs/IPs: Mixed Waste Integrated Demonstration**Currently Related Tasks:**

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Salt Separation	C. Barnes (INEL)	208-526-0864	T. Williams (ID)

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NEEDS STATEMENT: SC-3

ID/IP: Supercritical Water Oxidation Program

Work Breakdown Structure Number: 01.05.01.02.09

Focus Area:

Description of Need: Materials for the High-Temperature and Pressure SCWO Processing

The high temperatures, pressures, and corrosive environments associated with SCWO processing limit the type of materials that can be utilized for SCWO systems. The SCWO Program must identify and demonstrate materials of construction for SCWO process equipment, particularly the reactor, heat exchanges, and pressure let-down system. These materials must resist corrosion and degradation as well as thermal shock and interaction with radionuclides present in the wastes. Materials must be shown to be resistant in environments anticipated for processing DOE mixed wastes, including high concentrations of:

- Halogens, particularly Cl and F
- Acids, including hydrochloric, sulfuric, phosphoric
- Alkali metals
- Ammonia
- Metals in paint wastes
- Metals in waste water treatment spent carbon
- Heavy metals

The program will support testing of innovative materials that have the potential of enhancing the life of SCWO system components.

Window of Opportunity: Materials should be available by the middle of FY 96 to support testing on the HWPP and design efforts for the MWPP.

Other Applicable IDs/IPs: Mixed Waste Integrated Demonstration

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
SCWO Corrosion Testing	K. Garcia (INEL)	208-526-8852	T. Williams (ID)
Duel-Shell Reactor	R. Robertus (PNL)	509-376-0293	D. Trader (RL)

NEEDS STATEMENT: SC-4

ID/IP: Supercritical Water Oxidation Program

Work Breakdown Structure Number: 01.05.01.02.09

Focus Area:

Description of Need: Processes for Separating Radionuclides at SCWO Conditions

SCWO conditions provide unique potential for separating radionuclides. At SCWO conditions, a majority of the inorganics precipitate out as solids. The SCWO program will support innovating concepts for separating radionuclides from other inorganics and into specific species under supercritical water conditions.

Window of Opportunity: Proofs-of-concept should be complete by the middle of FY 96 to support testing to ensure incorporation of design constraints into the MWPP design. Pilot testing should be performed within the MWPP.

Other Applicable IDs/IPs: Mixed Waste Integrated Demonstration

Currently Related Tasks: None

NEEDS STATEMENT: SC-5

ID/IP: Supercritical Water Oxidation Program

Work Breakdown Structure Number: 01.05.01.02.09

Focus Area:

Description of Need: Deposition Chemistry Conditions

Processing of many materials with SCWO has resulted in deposits on system components such as reactor walls, let-down valves, nozzles, and exchanger tubes. In some cases, the deposits have resisted normal means of removal due to their "stickiness." The program will support research to develop an understanding of the chemistry of deposits at SCWO conditions. Examples include chemical forms of deposits, the role of materials of construction in deposition, and waste characteristics that determine the strength of adhesion. Testing would be required to be performed on wastes expected to be tested in the HWPP. These would include such species as sodium or calcium chloride or carbonate and other common ions such as sulfate, silicate, nitrate; species resulting from corrosion such as iron, nickel, and chromium; and RCRA-hazardous and heavy metals common in DOE wastes such as mercury, lead, and cadmium.

Window of Opportunity: Knowledge should be developed by the middle of FY 96 to support testing on the HWPP and design efforts for the MWPP.

Other Applicable IDs/IPs: None

Currently Related Tasks: None

NEEDS STATEMENT: SC-6

ID/IP: Supercritical Water Oxidation Program

Work Breakdown Structure Number: 01.05.01.02.09

Focus Area:

Description of Need: Mixing

Irrespective of the SCWO reactor volume or shape, a SCWO system must bring together water, waste, and oxidant. Complete mixing of these components is required for both efficient and safe operation of SCWO systems. The SCWO program will support innovative processes for ensuring effective mixing of fluid components.

Window of Opportunity: Processes need to be demonstrated by the middle of FY-96 to support testing on the HWPP and design efforts for the MWPP.

Other Applicable IDs/IPs: None

Currently Related Tasks: None

NEEDS STATEMENT: SC-7

ID/IP: Supercritical Water Oxidation Program

Work Breakdown Structure Number: 01.05.01.02.09

Focus Area:

Description of Need: Measurement of Corrosion

In situ measurement techniques are needed to accurately measure general corrosion, pitting, and stress corrosion within SCWO systems. The SCWO program will support techniques that are able to measure corrosion within a SCWO reactor under conditions that consist of pHs near 1, temperatures of 650°C, and pressures of 4000 psi.

Window of Opportunity: Processes need to be complete by the middle of FY 96 to support testing on the HWPP and design efforts for the MWPP.

Other Applicable IDs/IPs: None

Currently Related Tasks:

<u>Task</u>	<u>Principal Investigator</u>	<u>PI Phone</u>	<u>TPO</u>
Remote Measurement Using Electrochemical Methods	K. Garcia (INEL)	208-526-8852	T. Williams (ID)
Remote Measurement Using Ultrasonic Methods	D. Macdonald (PSU)	814-863-7772	T. Williams (ID)

SECTION 5.0

HOW TO GET INVOLVED:

WORKING WITH THE DOE OFFICE OF ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

5.0 HOW TO GET INVOLVED: WORKING WITH THE DOE OFFICE OF ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT

The U. S. Department of Energy provides a range of programs and services to assist universities, industry, and other private sector organizations and individuals interested in developing or applying environmental technologies. Working with DOE Operations Offices and management and operating contractors, the Office of Environmental Management uses conventional and innovative mechanisms to identify, integrate, develop, and adapt promising emerging technologies. These mechanisms include contracting and collaborative arrangements, procurement provisions, licensing of technology, consulting arrangements, reimbursable work for industry, and special consideration for small business.

Cooperative Research and Development Agreements (CRADAs)

EM will facilitate the development of subcontracts, R&D contracts, and cooperative agreements to work collaboratively with the private sector. EM uses CRADAs as an incentive for collaborative R&D. CRADAs are agreements between a DOE R&D laboratory and any non-Federal source to conduct cooperative R&D that is consistent with the laboratory's mission. The partner may provide funds, facilities, people, or other resources. DOE provides the CRADA partner access to facilities and expertise; however, no Federal funds are provided to external participants. Rights to inventions and other intellectual property are negotiated between the laboratory and participant, and certain data that are generated may be protected for up to 5 years.

Consortia will also be considered for situations where several companies combine their resources to address a common technical problem. Leveraging of funds to implement a consortium can offer a synergism to overall program effectiveness.

Procurement Mechanisms

DOE/EM has developed an environmental management technology development acquisition policy and strategy that uses phased procurements to span the RDDT&E continuum, from applied R&D concept feasibility through full-scale remediation. DOE EM phased procurements make provisions for unsolicited proposals, but formal solicitations are the preferred responses. The principle contractual mechanisms used by EM for industrial and academic response include Research Opportunity Announcements (ROAs) and Program R&D Announcements (PRDAs).

EM uses the ROA to solicit advanced research and technologies for a broad range of cleanup needs. The ROA supports applied research ranging from concept feasibility through full-scale demonstration. In addition, the ROA is open continuously for a full year following the date of issue, and includes a partial procurement set aside for small businesses. Typically, ROAs are published annually in the *Federal Register* and the *Commerce Business Daily* and multiple awards are made.

PRDAs are program announcements used to solicit a broad mix of R&D and DT&E proposals. Typically, a PRDA is used to solicit proposals for a wide-range of technical solutions to specific EM problem areas. PRDAs may be used to solicit proposals for contracts, grants, or cooperative agreements. Multiple awards, which may have dissimilar approaches or concepts, are generally made. Numerous PRDAs may be issued each year.

In addition to PRDAs and ROAs, EM uses financial assistance awards when the technology is developed for public purpose. Financial assistance awards are solicited through publication in the *Federal Register*. These announcements are called Program Rules. A Program Rule can either be a one-time solicitation or an open-ended, general solicitation with annual or more frequent announcements concerning specific funding availability and desired R&D agreements. The Program Rule can also be used to award both grants and cooperative agreements.

EM awards grants and cooperative agreements if fifty-one percent or more of the overall value of the effort is related to a public interest goal. Such goals include possible non-DOE or other Federal agency participation and use, advancement of present and future U.S. capabilities in domestic and international environmental cleanup markets, technology transfer, advancement of scientific knowledge, and education and training of individuals and business entities to advance U.S. remediation capabilities.

Licensing of Technology

DOE contractor-operated laboratories can license DOE/EM-developed technology and software to which they elect to take title. In other situations where DOE owns title to the resultant inventions, DOE's Office of General Counsel will do the licensing. Licensing activities are done within existing DOE intellectual property provisions.

Technical Personnel Exchange Assignments

Personnel exchanges provide opportunities for industrial and laboratory scientists to work together at various sites on environmental restoration and waste management technical problems of mutual interest. Industry is expected to contribute substantial cost-sharing for these personnel exchanges. To encourage such collaboration, the rights to any resulting patents go to the private sector company. These exchanges, which can last from 3 to 6 months, are opportunities for the laboratories and industry to better understand the differing operating cultures, and are ideal mechanisms for transferring technical skills and knowledge.

Consulting Arrangements

Laboratory scientists and engineers are available to consult in their areas of technical expertise. Most contractors operating laboratories have consulting provisions. Laboratory employees who wish to consult can sign non-disclosure agreements and are encouraged to do so.

Reimbursable Work for Industry

DOE laboratories are available to perform work for industry or other Federal agencies, as long as the work pertains to the mission of a respective laboratory and does not compete with the private sector. The special technical capabilities and unique facilities at DOE laboratories are an incentive for the private sector to use DOE's facilities and contractors expertise in this reimbursable work for industry mode. An advanced class patent waiver gives ownership of any inventions resulting from the research to the participating private sector company.

EM Small Business Technology Integration Program

The EM Small Business Technology Integration Program (SB-TIP) seeks the participation of small businesses in the EM Research, Development, Demonstration, Testing, and Evaluation programs. Through workshops and frequent communication, the EM SB-TIP provides information on opportunities for funding and collaborative efforts relative to advancing technologies for DOE environmental restoration and waste management applications.

EM SB-TIP has established a special EM procurement set aside for small firms (500 employees or less) to be used for applied research projects through its ROA. The program also serves as the EM liaison to the DOE Small Business Innovation Research (SBIR) Program Office and interfaces with other DOE small business offices.

Contact:

David W. Geiser, Acting Director
International Technology Exchange Division
EM-523
Environmental Restoration and Waste
Management Technology Development
U.S. Department of Energy
Washington, D.C. 20585
(301) 903-7940

EM Central Point of Contact

The EM Central Point of Contact can provide ready access to prospective research and business opportunities in waste management, environmental restoration, and decontamination and decommissioning activities, as well as information on EM-50 IPs and IDs. The EM Central Point of Contact can identify links between industry technologies and program needs, and can provide potential partners with a connection to an extensive complex-wide network of DOE Headquarters and field program contacts. It is the best single source of information for private-sector technology developers looking to collaborate with EM scientists and engineers. It provides a real-time information referral service to expedite and monitor private-sector interaction with EM.

To reach the EM Central Point of Contact, call 1-800-845-2096 during normal business hours (Eastern time).

Office of Research and Technology Applications

The Office of Research and Technology Applications (ORTAs) serves as a technology transfer agent at the Federal laboratories, provides internal coordination in the laboratory for technology transfer, and acts as an external point of contact for industry and universities. To fulfill these purposes, ORTAs licenses patents and coordinates technology transfer activities for a laboratory's scientific departments. It also facilitates one-on-one interactions between laboratory scientific personnel and technology recipients, and provides information on laboratory technologies with potential applications in private industry for state and local governments.

For more information about these programs and services, please contact:

Claire Sink, Director
Technology Integration Division
EM-521
Environmental Management Technology Development
U.S. Department of Energy
Washington, D.C. 20585
(301) 903-7928

PUBLICATIONS

Information on completed and on-going projects can be obtained from a number of sources. The Office of Technology Development, through its Offices of Research and Development and Demonstration, Testing, and Evaluation, has published a *FY 93 Program Summary (GPO DOE\EM-010P)*, which summarizes significant FY 93 programmatic information and accomplishments. Contact 1-800-845-2096 for information about this and other resources. Fact sheets and technology summaries have been written for the following programs:

1. Buried Waste Integrated Demonstration
2. Characterization, Monitoring, and Sensor Technology Integrated Program
3. Dynamic Underground Stripping Integrated Demonstration
4. Efficient Separations and Processing Integrated Program
5. Environmentally Conscious Manufacturing Integrated Demonstration
6. Heavy Metals Contaminated Soils Project
7. In Situ Remediation Integrated Program
8. Minimum Additive Waste Stabilization Program
9. Mixed Waste Integrated Program
10. Mixed Waste Landfill Integrated Demonstration
11. Resource Recovery Project
12. Robotics Technology Development Program
13. Rocky Flats Compliance Program
14. Supercritical Water Oxidation Program
15. Underground Storage Tank Integrated Demonstration
16. Uranium in Soils Integrated Demonstration
17. U.S. Department of Energy/U.S. Air Force Memorandum of Understanding Program
18. Volatile Organic Compounds in Arid Soils Integrated Demonstration
19. Volatile Organic Compounds in Non-Arid Soils Integrated Demonstration
20. Waste Component Recycle, Treatment, and Disposal Integrated Demonstration

SECTION 6.0
EM PROGRAM OVERVIEW

6.0 EM Program Overview

Organization Structure

The EM organization was established to provide visibility, focus, and accountability for DOE's waste management and cleanup efforts.

The EM Office of Policy and Program Information (EM-4) serves as a central coordinate for DOE/EM public participation and program information activities. EM-4 establishes policy and guidance, and conducts and coordinates public participation activities inside and outside the agency. It's goal is to identify public concerns, needs, and objectives through two-way communications between DOE and the public before decisions are made. This interactive process improves DOE understanding of public concerns, and enhances the public's understanding of DOE decisions and subsequent technology development activities.

The EM Office of Planning and Resource Management (EM-10) supports program office financial management, procurement, and administrative activities and coordinates the annual update of the EM Strategic Plan and Five-Year Plan.

The EM Office of Oversight and Self-Assessment (EM-20) performs independent internal oversight within EM to ensure compliance with environmental and safety laws/regulations and with DOE Quality Assurance policies. EM-20 is also charged with enhancing the technical validity and cost-effectiveness of programs and projects. In addition, it is responsible for independent cost estimating functions.

The EM Office of Waste Management (EM-30) has program responsibilities for waste management at all DOE sites, including the treatment, storage, and disposal of several types of waste: transuranic, low-level radioactive, mixed, and solid sanitary. EM-30 is also responsible for the storage, treatment, and processing of defense high-level radioactive waste, waste minimization efforts, and corrective activities at waste management facilities.

The EM Office of Environmental Restoration (EM-40) has program responsibilities for remediating inactive hazardous and radioactive waste sites at all DOE installations and some non-DOE sites, including remedial actions and decontamination/decommissioning activities.

The EM Office of Technology Development (EM-50) has program responsibilities for developing better, faster, cheaper, and safer technologies for meeting DOE's 30-year goal for environmental restoration and waste management, and for managing crosscutting activities.

The EM Office of Facility Transition and Management (EM-60) plans, implements, and manages the orderly transition of facilities from their operational base to EM-30 and EM-40 and their subsequent disposition. EM-60 establishes and implements a consistent process to safely deactivate and dispose of DOE facilities.

Office of Technology Development EM-50

The Office of Technology Development (EM-50) has the overall responsibility to develop technologies to meet DOE's 30-year goal for environmental restoration. Activities within EM-50 include applied research and development, and demonstration, testing, and evaluation of new and existing technologies.

Figure 2. Office of Environmental Restoration and Waste Management (EM) Organizational Structure

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