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Characterization,
Monitoring,
& Sensor
Technologies

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Progress Reports

Characterization,
Monitoring,
& Sensor Technology
Crosscutting Program

Federal Energy
Technology
Center,
Morgantown

Contacts

This report is prepared by Special Technologies Laboratory and funded by the Characterization, Monitoring, and Sensor Technology-Crosscutting Program (CMST-CP). Reported information is the result of a joint effort between the CMST-CP and the Federal Energy Technology Center—Morgantown (FETC).

If you do not wish to receive these monthly reports, please inform the CMST-CP staff at (515) 232-0474.

If you have questions or comments about report entries, please direct them to the Principal Investigators (PIs) or Contract Office Representatives (CORs) listed at the end of each entry or to the program representatives listed below.

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This index lists FY98 FETC projects by number, name, and document location of brief descriptions of their major activities for the month. It also identifies which technologies the project involves. ("**P**" indicates primary involvement.)

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AR21-95MC32110	Measurement of Radionuclides Using Ion Chromatography and Flow-Cell Scintillation Counting	5	**P**			✓	
AR21-96MC33077	Tomographic Site Characterization Using Cone Penetrometer, Electrical Resistivity Tomography, and Ground Penetrating Radar	4	**P**				
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AC21-96MC33124	*In Situ* Permeability Measurements with Direct Push Techniques	2	**P**				
AC21-96MC33125	Subsurface Barrier Validation with the SEAtrace™ Monitoring System		**P**	✓			
AC21-96MC33128	*In Situ* Tritium Beta Detector	7	**P**				
AC21-92MC29108	Field Raman Spectrograph for Environmental Analysis	19	✓	**P**	✓	✓	
AR21-93MC30363	Robotic End Effector for Inspection of Storage Tanks	16		**P**			
AR21-95MC32087	An Advanced, Open-Path, Atmospheric Pollution Monitor	17	✓	**P**			
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AC21-93MC30173	Waste Inspection Tomography	22	✓		**P**	✓	
AC21-96MC32194	A Continuous Emission Monitor for Toxic Metals in the Offgases of Thermal Treatment Facilities				**P**		
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Project Number	Project Name	Page	Subsurface Contaminants	Tanks	Mixed Wastes	D & D	Coordination
AC21-93MC30172	Characterization for Radioactive Contamination Inside Pipes with the Pipe Explorer™ System	31	✓			**P**	
AC21-93MC30175	Portable Sensor for Hazardous Waste		✓		✓	**P**	
AC21-93MC30176	3-Dimensional Integrated Characterization and Archiving System (3D-ICAS)	30	✓		✓	**P**	
AC21-94MC31190	Coherent Laser Vision System				✓	**P**	
AR21-95MC32093	Diagnostics and Data Fusion of Robotic Sensors					**P**	
AR21-95MC32115	Multisensor Inspection and Characterization Robot for Small Pipes (MICROSPI)					**P**	

Monthly Highlights

This section summarizes some of the most significant progress achieved within the CMST area during the reporting period. More information about each project can be found on the page indicated within each summary.

- **Characterization of Radioactive Contamination in Soil**
  The Formerly Utilized Sites Remedial Action Program (FUSRAP) at Luckey, Ohio, funded deployment of the laser-induced breakdown spectroscopy (LIBS) technology to measure beryllium concentrations, *in situ* and in real time, in contaminated soil at the 40-acre site. Deployment during a six-week field project in October and November 1997 led to the successful identification of beryllium hot spots. Preliminary benefit analysis indicated a cost reduction estimate of 30 to 50% and a schedule reduction estimate of 30%, compared to selected baseline technologies. The technology is now being considered for use during a six-month-long remediation phase scheduled for 1998 in which detailed beryllium characterization will guide abatement of the soil contamination. (Page 1)

- **Characterization of Radioactive Contamination Inside Pipes with the Pipe Explorer™ System**
  The Pipe Explorer™ was deployed to Pacific Gas and Electric (PG&E) to conduct eight surveys in a total of 350 feet of concrete-embedded piping to determine the adequacy of cleaning. It was able to identify piping systems that are suitable for free release without excavation and piping systems that require further cleaning or excavation for disposal as low-level radioactive waste. The use of the Pipe Explorer™ saved PG&E money by free releasing a portion of the piping system and avoiding the costly excavation of pipe. (Page 31)

- **Waste Inspection Tomography (WIT)**
  WIT passed precision and accuracy tests on all drums assayed with the active and passive computed tomography (A&PCT) technique as part of the Capability Evaluation Program and the Performance Demonstration Program (PDP) testing in October 1997 at Idaho National Engineering and Environmental Laboratory. These include leached metals, MSE salts, sludge, Raschig rings, combustibles, and zero matrix drums. Bio-Imaging Research received a letter from the DOE Carlsbad Area Office (CAO) that as of December 18, WIT was approved by the CAO for nondestructive assay of TRU waste drums using A&PCT based on cycle 4 testing of the PDP. (Page 22)

Monthly Highlights - continued

- **Development of a Long-Term, Post-Closure Radiation Monitor**
  The field test plan was completed and issued to the Fernald Environmental Management Project (FEMP) site. All five system probes were installed at the predesignated FEMP site locations during December 12 to 19. These five systems are situated in the inactive flyash pile (two), Paddy Run (one), and Solid Waste Landfill (two). Considerable interest in this Radiation Monitoring System has been expressed by FEMP personnel for a number of applications at the site. (Page 11)

- **Development of a Magnetic Resonance Monitor for Technetium-99 Column Breakthrough**
  Initial results from using a prototype 2.05 Tesla magnet system demonstrated that it is possible to monitor pertechnetate species from high concentrations to a lower detection threshold of 167 μCi/l. This sensitivity is below the Class A disposal limit of 300 μCi/l. Experiments followed the prescribed test protocols, i.e., specimens were analyzed in 5-mm-diameter tubes with an active volume of 0.2 ml and in less than 14-minute analysis time. Additional improvements in the instrumentation to reduce the minimal detection threshold are in progress. (Page 21)

- **Characterization, Monitoring, and Sensor Technology Crosscutting Program FY98 Multi-Year Program Plan (MYPP)**
  CMST team members worked together to complete the MYPP document, which was submitted to DOE Headquarters on December 31. The MYPP contains information regarding the program's purpose, Focus Area mission, work scope, performance metrics, and program execution, including key accomplishments in FY97 and major activities for FY98 through FY06. (Page 40)

Subsurface Contaminants

Plumes

Field Analysis

Fiber-Optic/Cone Penetrometer System for Subsurface Heavy Metal Detection

Objective

This effort will develop a fiber-optic, laser-induced breakdown spectroscopy (LIBS) sensor and cone penetrometer system for subsurface detection and analysis of heavy metals. A rugged, small-sized, multianalyte sensor system will aid in characterizing and remediating contaminated land sites by reducing costs and analysis time.

The base phase involved the design, construction, and evaluation of fiber-optic probes and simulated penetrometer configurations to prove feasibility of the concept for analysis of soil samples. Probes were evaluated for their ability to perform quantitative analysis of Cr and Pb (or other DOE-specified elements). The option, in progress, will consist of fabricating an integrated, rugged LIBS/penetrometer system to be tested in the laboratory and at a DOE field site.

Progress

Evaluation of correlation data for beryllium-contaminated soil using results from 50 samples provided by the Formerly Utilized Sites Remedial Action Program (FUSRAP) began. In addition, the PI worked on input to the final report and planned for additional diagnostic tests, necessary equipment redesign, and additional field testing that will be required before field deployment.

In an additional effort, the FUSRAP at Luckey, Ohio, funded deployment of the laser-induced breakdown spectroscopy (LIBS) technology to measure beryllium concentrations, *in situ* and in real time, in contaminated soil at the 40-acre site. The site was used during the early 1950s by a private-sector company to operate a beryllium manufacturing plant for the Atomic Energy Commission. Deployment during a six-week field project in October and November 1997 led to the successful identification of beryllium hot spots. The technology is now being considered for use during a six-month-long remediation phase scheduled for 1998 in which detailed beryllium characterization will guide abatement of the soil contamination.

Benefits from conducting screening analyses for beryllium on-site and in real time included preliminary cost reduction estimates of 30 to 50% and schedule reduction estimates of 30%, compared to selected baseline technologies. Furthermore, the FUSRAP was transferred from the DOE to the U.S. Army Corp. of Engineers

(USACE) with the new fiscal year. The DOE-developed technology promises to see continued use by the USACE at this FUSRAP site and possibly other DoD sites.

PI: Stephen Saggese, Science & Engineering Associates, (505) 884-2300

FETC COR: Karen Cohen, (412) 892-6667

Geophysical/Hydrologic Characterization

In Situ Permeability Measurements with Direct Push Techniques

Objective

This project will develop the measurement model, perform validation in the laboratory, and conduct a field test of a prototype *in situ* permeability measurement system integrated with direct push techniques such as cone penetrometers. This effort involves two major thrusts: development of a measurement model that will perform in the cone penetrometer operating environment and engineering the measurement package to satisfy the size and operational constraints of penetrometer applications.

Progress

The contractor met with Wes Bratton on December 5 and reviewed the detailed design of the prototype penetrometer section. Minor changes resulted from this meeting and will be incorporated in the final design. The data system assembly is essentially completed, with a few minor changes anticipated when the probe is delivered for initial testing. The contractor is researching other techniques for *in situ* permeability measurements for performance assessment.

PI: Bill Lowry, Science and Engineering Associates, (505) 424-6955

FETC COR: Karen Cohen, (412) 892-6667

Measuring Fuel Contamination Using High-Speed Gas Chromatography and Cone Penetration Techniques

Objective

This project will develop a complete system for detecting and quantifying the level of fuel contamination present in subsurface soils using cone penetrometer testing (CPT) techniques and high-speed gas chromatography (GC). A heated CPT sampling probe will be developed that will volatilize organic contaminants from the subsurface

environment and convey them to the surface via heated transfer lines for high-speed GC analysis, or trap them downhole on adsorbent media for subsequent laboratory analysis. A screening mode will be used to detect contamination. An analysis mode will be used to quantify the concentrations present. A downhole purge system for groundwater will also be developed for use with the trap or up-hole high-speed GC.

Progress

Laboratory testing was conducted to compare the transfer efficiencies of two types of Teflon tubing to be used as a heated transfer line for both the downhole thermal desorption and cone *in situ* purge probes. The tubings will be used in the heated transfer lines to transport volatile organic compounds (VOCs) from the downhole sampling probes to an uphole surface acoustical wave/gas chromatograph (SAW/GC). As discussed in the October report, Teflon PFA and Teflon FEP were selected for comparison to determine which tubing exhibits less adsorption of both halogenated and aromatic VOCs. The test apparatus was assembled and the test procedures were executed as described in the approved test plan. A brief description of the test procedures is presented below:

- *Experimental procedures—tubing preparation and baseline sample collection.* The tubing was cleaned before testing by baking in an oven for two hours at 110ºC while flushing with ultra high purity helium. Baseline samples were collected by flushing each of the Teflon lines with 700 mls of zero-grade air at a flow rate of 50 ml min^{-1}. These samples were collected on Tenax TA adsorbent tubes and were analyzed in accordance with a modified EPA Method TO-1 for the target analytes, which include tetrachloroethylene (PCE), trichloroethylene (TCE), toluene, and m-xylene. Baseline samples were collected at both ambient (25ºC) and at elevated (110ºC) temperatures. The results of these sample analyses will be used to evaluate the level of residual target analytes emanating from the tubings resulting from the manufacturing process or environmental exposure.
- *Target analyte mixture preparation—concentrated mixture.* Concentrated gaseous standards were prepared in a static dilution bottle (SDB) using a technique developed by the EPA for air analysis (U.S. EPA, 1988). First, an equimolar mixture of neat target analytes, referred to as "soup," was prepared by injecting the appropriate volume of each target analyte into a 4-ml vial. By injecting a known volume of the soup through the Mininert valve into the SDB and allowing it to vaporize/equilibrate, a known concentration mixture of the target analytes was prepared. With a nominal volume of 2 liters in the SDB, 17.2 microliters of soup were injected to produce a 500-ppm concentrated gaseous mixture of target analytes.

- *Diluted mixture.* To make the diluted mixture of the target analytes, 4 mls of the concentrated gaseous mixture was withdrawn from the static dilution vessel with a gas-tight syringe and transferred to a 25-liter Teflon bag that had been thoroughly purged, evacuated, and filled with 20 liters of zero-grade air. The result was 20 liters of target analyte mixture at a concentration of approximately 100 ppb.

PI: Wes Bratton, Applied Research Associates, (802) 763-8348

FETC COR: Steve Cooke, (304) 285-5437

Tomographic Site Characterization Using Cone Penetrometer, Electrical Resistivity Tomography, and Ground Penetrating Radar

Objective

This project will develop a ground penetrating radar (GPR) cone penetrometer (CPT) cross-hole measurement system for tomographic imaging and will also jointly develop an electrical resistivity tomographic (ERT) cone penetrometer cross-hole measurement system with Lawrence Livermore National Laboratory (LLNL). These new cone penetrometer systems will be used for better subsurface site characterization and monitoring at hazardous waste sites. Integrating GPR and ERT with cost-effective cone penetrometer technology will greatly reduce the costs associated with site characterization and long-term environmental monitoring. At the end of this project, the DOE will be able to perform GPR and ERT cross-hole imaging using the cone penetrometer to install GPR antennas and ERT electrodes.

Progress

December activities included:

- Re-evaluation of the ERT software and continued processing of the cross-hole ERT data from the MWD Hydro test site.
- Suspension of planning another deployment at Savannah River Site because of insufficient funds. A request was made for additional funds for field testing at the dense non-aqueous phase liquid - contaminated site.
- Initial preparation of the final report.

PI: Rexford Morey, Applied Research Associates, (802) 763-8348

FETC COR: Karen Cohen, (412) 892-6667

Sensors

Measurement of Radionuclides Using Ion Chromatography and Flow-Cell Scintillation Counting with Pulse Shape Discrimination for ER/WM Applications

Objective

This effort will develop laboratory techniques for measuring radionuclides by using ion chromatography for elemental selectivity and flow-cell scintillation counting with pulse shape discrimination for isotopic selectivity. The radionuclides measurement methodology developed by this work will facilitate performance of on-line counting of both aqueous and nonaqueous samples at minimum detectable concentrations (MDCs) that are well below requirements for waste samples and are low enough for environmental screening. When coupled with off-line counting, MDCs would approach typical regulatory limits. The project will be implemented in two parts: a base program and an option. In the base program, the contractor will focus on sample preparation and radiation detection components for developing the ion chromatography/on-line scintillation counting for environmental/waste samples.

Progress

Nine milliliters of Monoflow 5 and Ultima Flo were mixed with one milliliter of sample and counted. Unmodified Ultima Flo and Monoflow 5 exhibited spillovers of 11% and 7.5%, respectively. The scintillation cocktails were then modified with the addition of naphthalene at one gram per 10 mL and recounted. The modified Ultima Flo and Monoflow 5 had lower spillovers: 7.0% and 4.3%, respectively. Due to its lower spillover values and better separation, Monoflow 5 was chosen over Ultima Flow for further testing as a "flow-cocktail."

PI: Angela Harrington, South Carolina Universities Research and Education Foundation, (864) 656-5569

FETC COR: Jagdish Malhotra, (304) 285-4053

Development of an On-Line, Real-Time, Alpha-Radiation Measuring Instrument for Liquid Streams

Objective

Phase 1 involved the design, development, and testing of a laboratory-scale instrument. Testing will initially be conducted using standard aqueous uranium and other low-level radioactivity solutions. Further laboratory testing will simulate field test conditions by using samples obtained from selected DOE sites. In phase 2, the phase 1 instrument will be scaled up and field tests will be performed at selected DOE sites to demonstrate

the suitability of the device to detect and measure uranium and other radionuclide concentrations under field conditions. Surface, ground, and process waters will be tested.

Progress

A revised statement of work and cost plan were received and approved by FETC, which will allow the project to proceed with field testing at high-priority Oak Ridge sites. Originally, the Thermo Alpha Monitor (TAM) system was designed to handle solutions in a flow-through wet analysis chamber. This arrangement required simple liquid handling equipment such as pumps and solenoid valves to conduct sampling and analysis. Soon after being awarded the contract's base phase, the contractor proposed an improved concept using a proprietary film that would collect alpha emitters; then, the film must be washed, dried, and placed in a separate counting chamber. While this improved the detection limits and instrument response time, it is inherently a much more difficult set of tasks to automate. The revisions to the statement of work include completion of the automation task before transporting the TAM to Oak Ridge for field testing at Oak Ridge National Laboratory, Y-12 plant, and municipal waste water treatment plant sites.

The PI continues to investigate interest in the technology, which has wide application across the DOE complex as well as private industry in detection, remediation, and long-term monitoring of alpha radiation from various water sources.

PI: Keith Patch, Thermo Power Corp. (Tecogen Division), (617) 622-1400

FETC COR: Richard Bush, (412) 892-6426

New Environmental Measurement while Drilling

Objective

This project has demonstrated a radiation sensor and will provide additional sensing capabilities to an operational Environmental-Measurement-While-Drilling (EMWD) platform. Specific sensors for integration include a magnetometer for continuous distance and depth measurement capability as well as a heavy metal sensor.

Progress

We are still working to identify a partner site for the "Hot Site" demonstration. Hanford ER has requested that we visit the site to brief them on the technology. We are also making contacts with the U.S. Navy at Port Hueneme, California; Savannah River Site; and Oak Ridge National Laboratory.

As reported last month, the modified EMWD system including the magnetometer, an array of three accelerometers, and continuous distance measurement capability was successfully demonstrated at the Charles Machine Works, Inc. testing range. We are analyzing the data from the test. We are comparing the subsite and survey data with our position data.

PI: Cecelia Williams, Sandia National Laboratory-Albuquerque, (505) 844-5722

In Situ Tritium Beta Detector

Objective

This task will design, develop, demonstrate, and deliver a monitoring system capable of detecting and quantifying tritium *in situ* in ground and surface water and in water from effluent lines prior to discharge into public waterways. This tritium beta detector will be a compact, immersible sensor; have a large wetted sensor surface area; possess high sensitivity and high specificity to tritium; have a near real-time response; be rugged; and contain integrated electronics.

In the base contract, the contractor will develop a set of target specifications and an engineering design of a system to meet those specifications. In option 1, the contractor would build the subscale prototype designed in the base contract and evaluate its performance in a set of controlled laboratory tests. In option 2, the contractor would build a final prototype and demonstrate the performance of the system at a DOE or representative test site.

Progress

As reported last month, a draft topical report was delivered to the DOE for review. FETC distributed this document and other pertinent information to the Subsurface Contaminants Focus Area (SCFA), CMST-CP personnel, and Environmental Measurements Laboratory (EML) personnel for review and comment to determine if continuation of the project is warranted. A decision should be reached by early March.

It is clear that McDermott is not ready to build a prototype instrument, as the objective performance specifications have not been met. Any further activity on the project would initially focus on extending phase 1 development to continue working with the existing scintillating optical fibers to find an embodiment that will give the desired sensitivity to tritium beta.

In the topical report, McDermott recommends that further development work be undertaken to increase the fluor dopant concentration of the polystyrene optical fiber above 2% until the optical photon self-absorption limit is observed. McDermott discussed this subject with a consultant at Princeton University who is an expert in polymer chemistry, and he reportedly believes that it is feasible to increase the dopant

concentration up to possibly 8%. To achieve these large doping levels, it will be necessary to inhibit crystallization of the fluor molecules. To do this, the fluor molecules could be bound in a monomer, which in turn could be polymerized into the polystyrene to produce a copolymer.

According to McDermott, in addition to significant improvements in sensitivity to low energy beta, this approach has another major advantage compared to the present process, which simply mixes the fluor into polystyrene. By creating a monomer and copolymer, the fluor molecules will be bound into the polystyrene molecular structure. The resulting fiber should be much more stable, which should significantly reduce time-dependent changes in sensitivity that McDermott observed and reported. In addition, the fiber should be very stable when immersed in water, and the fluor is not expected to leach out.

PI: John Berthold, McDermott Technologies, (330) 829-7271

FETC COR: Ron Staubly, (304) 285-4991

Contaminant Transport

Analog Site for Characterization of Fractured Rock

Objective

This project will develop a suite of reliable tools and methodologies that can be used for characterizing flow and contaminant transport in fractured rock. The work will focus on the Idaho National Engineering and Environmental Laboratory (INEEL) site and will include development of a conceptual model for flow and transport in the fractured basalts of the sole-source Snake River Plain Aquifer there. Of the specific technologies and methodologies being developed and investigated, many will be applicable at every contaminated site and some will have to be modified for use in a different geology.

Progress

The results of the project were presented at:

- the American Geophysical Union Fall 1997 Meeting in San Francisco (two poster presentations were given)
- the meeting of the Committee on Technologies for Cleanup of Subsurface Contaminants in the DOE Weapons Complex, Commission on Geosciences, Environment, and Resources of National Research Council (held December 15 in Livermore, California)

Analysis of the 1997 field infiltration test continued. In addition, preparation and review of journal articles summarizing project results continued.

PI: Christine Doughty, Lawrence Berkeley National Laboratory, (510) 486-6453

Integrated Geophysical and Hydrological Characterization of Transport through Fractured Rock

Objective

This project is interpreting data collected at the Large Scale Infiltration Test with the objective of demonstrating innovative integrated interpretation technologies to better understand fluid flow through fractured media. This will allow improvements in the ability to locate, map, and design remediation systems for subsurface contaminants in fractured rock (e.g., basalt, limestone, and granite).

Progress

Closeout activities associated with the technical task plan began. The data flow from the Box Canyon site continues to flow in, but the final report will only include data collected to January 16. We plan to retrieve the equipment from Box Canyon before the project's February 27 completion date.

PI: Buck Sisson, Idaho National Engineering and Environmental Laboratory, (208) 526-1118

JCCEM Contaminant Transport Studies (Pacific Northwest National Laboratory)

Objective

This project is part of a Joint Coordinating Committee for Environmental Restoration and Waste Management (JCCEM) effort on contaminant transport studies. Participants include Pacific Northwest National Laboratory (PNNL) and Westinghouse Savannah River Co. (WSRC). Program objectives include:

- establishing a mechanism for joint collaborative investigations between U.S. and Russian scientists.
- reviewing and studying data from Russian and American sites appropriate for joint coordinated activities on contaminant transport issues relevant to the needs of the DOE in developing, refining, and implementing U.S. contaminant transport models.
- publishing Russian results in English, organizing workshops to disseminate Russian information to U.S. scientists, and promoting binational cooperation.

Progress

We continued preparing for participation in the January 1998 workshop in Moscow with Environmental Measurements Laboratory, PSA Hydrospetzgeologiya, PA Mayak, and British Nuclear Fuels Ltd., including preparation of a geochemical-modeling strategy.

We continued digitizing the Mayak site characterization data received in September 1997 and converting all of our Mayak GIS coverages to be used in modeling to the Russians' Mayak plane coordinate system.

A paper entitled "Development of a Three-Dimensional Regional Hydrogeologic Model of the Mayak Site, Urals," by C.R. Cole, M.D. Williams, M.G Foley, E. Drozhko, L. Samsonova, N. Vasil'kova, A. Zinin, G. Zinina, and K. Ter-Saakian, was submitted on December 11 to Spectrum '98 for publication in the proceedings.

PI: Michael Foley, Pacific Northwest National Laboratory, (509) 372-4671

Landfills

Containment

Electrical Resistance Tomography for Subsurface Imaging

Objective

Electrical resistance tomography (ERT) has been developed to map changes in formation water content caused by the subsurface processes of electrokinetic remediation and leaks from waste storage tanks. In FY98, this project will evaluate the utility of ERT for monitoring the emplacement of jet grouting and viscous liquid barriers. Additionally, a field experiment to map the extent of subsurface free product dense nonaqueous phase liquids (DNAPLs) using a combination of downhole Raman fiber optic sensor and cross borehole electrical impedance tomography (for magnitude and phase of the resistivity as a function of frequency) will be conducted.

Progress

Progress was made on a final draft for the electrical impedance tomography paper. Comments from the internal review were added.

A trip to Dover Air Force Base in early December allowed collection of post-emplacement ERT data on the phase 2 barrier. Following this, the data collection system was shipped to Lawrence Livermore National Laboratory for the winter.

We have preliminary 2D inversions of pre- and post-emplacement data from phase 2. The 3D inversions are running. (They use a very large mesh and require about six days of CPU time.)

PI: Bill Daily, Lawrence Livermore National Laboratory, (510) 422-8623

Post-Closure Monitoring

Development of a Long-Term, Post-Closure Radiation Monitor

Objective

This project is designed to develop a low-cost, multi-point radiation monitoring system for long-term, continuous monitoring of radiation levels in the vadose zone of hazardous waste sites. Based on gamma spectroscopy, the system will be able to monitor to depths of more than 50 meters without the necessity of drilling wells. The system will be capable of nearly unlimited numbers of completely passive, permanently installed probes. None of its electronic components will be belowground, and a single, aboveground opto-electronics unit will be capable of multiplexing a large number of

independent probes via optical fibers. This combination will form a system not commercially available now. In phase 1, McDermott Technologies configured a system from commercial components that could monitor radionuclides in soil to pCi/g levels. The project is in phase 2.

Progress

The field test plan was completed and was received and issued to the Fernald Environmental Management Project (FEMP) site. Site worker training was completed under safety requirements. All five system probes were installed at the predesignated FEMP site locations during December 12 to 19. These five systems are situated in the inactive flyash pile (two), Paddy Run (one), and Solid Waste Landfill (two). There has been considerable interest in this Radiation Monitoring System by the FEMP personnel for a number of applications at the site. A meeting is being planned at the site to discuss the potential applications. DOE representatives will be invited to attend once the meeting agenda is finalized.

PI: Stuart Reed, McDermott Technologies, (330) 829-7350

FETC COR: Jagdish Malhotra, (304) 285-4053

Alternative Landfill Cover Demonstration

Objective

The Alternative Landfill Cover Demonstration (ALCD) is a large-scale field test at Sandia National Laboratory. Two baseline covers (traditional Resource Conservation and Recovery Act subtitle 'D' for municipal landfills and traditional Resource Conservation and Recovery Act subtitle 'C' for hazardous mixed waste landfills) are constructed side-by-side with four alternative cover designs for comparison based on performance, cost, and ease of construction. The covers are being monitored for all water balance variables and supporting data. This field-obtained data will be compared with results obtained from predictive computer models for validation of the models. In addition, five years of water balance data would be deemed adequate for regulatory approval of the alternative covers, and this project is expected to complete data collection by the year 2001.

Progress

The ALCD is collecting data both manually and through continual automated methods. Data being collected include all water balance variables for each of the six test covers. These variables include precipitation, surface runoff, soil moisture changes, lateral drainage, and percolation. Weather data are also being collected. Vegetation and soil nutrient aspects are manually obtained twice a year. This is a lengthy process that takes several months.

The 24 vegetation plots of eight different surface treatments are being monitored on a weekly basis. Soil moisture measurements are obtained at various depths for each plot.

All collected data are compiled monthly and analyzed. Progress reports will be presented annually.

PI: Steven Dwyer, Sandia National Laboratory, (505) 844-0595

Identification of DOE EM Post-Closure Monitoring Needs and Requirements

Objective

This project will determine and document the existing and evolving post-closure monitoring requirements throughout DOE EM sites. In addition, the stability of the requirements will be determined and, where needed, tracking methods will be recommended. The primary deliverable will be a DOE EM post-closure monitoring needs summary with an analysis showing the most commonly occurring needs.

Progress

Initial planning and definition of survey goals were completed, and the review of Internet and public disclosure resources for targeted facilities began.

Internet and home page resources are being used to establish a baseline for evaluation of the needs as perceived from the site perspective. A preliminary assessment of the Hanford site technology needs was reviewed, and further Internet site surveying is being conducted.

Additional contacts were made to ensure that key personnel from the Focus Area management staff will have an opportunity to review and comment on the ongoing survey. Further interactions with CMST-CP management personnel were made, and discussions are ongoing regarding the necessary output of this project for management implementation.

PI: M. A. Ebadian, Florida International University, (305) 348-3585

Technology Survey and Verification

Current Practice of Environmental Characterization and Monitoring Technologies

Objective

This project will document current practices of environmental technologies in the areas of site characterization and waste/processing monitoring. This activity will (1) collect, assess, and compile information from technology users and purchasers in DOE and EPA environmental management programs and (2) produce a database for technology users, purchasers, and project sponsors. The interactive database will be published on the Internet. Additional technologies used in other federal programs (i.e., the DoD, DoC, and DoI) as well as at private company sites will be included in the out-years.

Progress

The PI discussed the survey database with the Internet site developers.

PI: Stephan Weeks, Special Technologies Laboratory, (805) 681-2262

Validation and Verification of CMST-CP Sensors at the Hemispheric Center for Environmental Technology Analytical Laboratory

Objective

This project is intended to verify field data obtained by deployed technologies for the closure and post-closure of various waste sites throughout the country. The sensors used by these technologies are to be validated to establish criteria for conditions that provide users, regulators, and stakeholders with confidence that the site is clean based on the agreed-upon standards. Validation of the data is intended to ensure that they are accurate and precise and that they describe the true state of the location to which they are applied. This project scope also includes examination of existing DOE needs to identify other validation or characterization opportunities that could be initiated immediately.

Progress

In meetings this month with a CMST-CP project facilitator—Dr. Glenn Bastiaans of Ames Laboratory—it was concluded that the validation project should take on a proactive rather than reactive role in its implementation. The necessity of waiting until an appropriate technology and sensor system could be selected, approved, and deployed would indefinitely delay the initiation of work. To remedy this, it was generally agreed that the project be transformed by examining other areas in which the laboratory capabilities could be immediately applied.

Various methods of approach were discussed as to how best to implement a newly expanded direction for the project. Among these were the following: (1) examination of individual DOE site needs using the Internet, (2) EPA requirements through sources such as the Environmental Technology Verification Program (ETV), (3) state EPA technology requirements, (4) calls to industry for potential commercial technologies appropriate for closure based on DOE needs, and (5) use of the Innovative Technology Summary Reports (ITSRs or Greenbooks).

Strategies for accomplishing these goals centered on the following: (1) acting as a third-party objective entity to verify data obtained by laboratories that may have conflicting interests, (2) acting as a secondary validation laboratory to supplement data produced by a primary one, (3) evaluation of field-deployable technologies before their deployment followed by recommendations as to their applicability, and (4) use of personal contact of key individuals to initiate sources to identify site needs.

PI: M. A. Ebadian, Florida International University, (305) 348-3585

High-Level Waste Tanks

Safe Storage

Robotic End Effector for Inspection of Storage Tanks

Objective

This effort will develop and demonstrate a robotic tank inspection end effector (RTIEE) capable of both visual and nondestructive evaluation (NDE) of the interior walls of stainless steel and carbon steel waste storage tanks. It will detect and size corrosion damage caused by surface pitting in stainless steel and carbon steel tank walls. This system will be based on an alternating current field measurement (ACFM) technology that provides remote operator video data and indicates wall corrosion. The inspection robot operator will be presented with a graphical ACFM appraisal of the condition of the scan area on the video monitor.

In phase 1, the contractor defined end effector system requirements to include designing, fabricating, assembling, and testing the pre-prototype system at a robotic lab configured to simulate representative manipulators. Software development work is compatible with the Generic Intelligent System Control (GISC).

Progress

Regarding the RTIEE, the printed circuit cards for the revised at-tank electronics needed to support the camera and upgraded short circuit protection were received. Manufacture of the updated RTIEE back plate that mates to the INEEL tool interface plate began.

The subcontractor, Technical Software Consultants, completed the design and manufacture of the standoff sensor system for the RTIEE scanner frame. Delivery of the system including three standoff sensors and the radiation-hardened electronics was completed in late December. Delivery of the system firmware and the integration and testing of the RTIEE with the new standoff sensor are scheduled for January.

Fly-by testing of the radiation-hardened RTIEE scanner frame assembly with the Puma was successfully completed. At a distance of 0.25 inches, the RTIEE was able to detect all of the cracks in the plate, at traverse speeds up to 1.3 inches per second. The only exception to this was a very large but shallow crack (2.91 inches x 0.05 inches) that was clearly detected at speeds up to 0.5 inches per second.

Oceaneering Space Systems (OSS) completed the Tank 16 annulus sampling tool cold test on December 3 at the Savannah River Site. Two salt sampling tools were demonstrated with the long reach pole and camera system. The Westinghouse team

identified several new design issues related to glove box interfaces. OSS prepared a concept design to meet the revised design requirements. The current plan is to perform the salt sampling in mid-February.

PI: Tom Gaseor, Oceaneering Space Systems, (713) 488-9080 ext. 3208

FETC COR: Maria Vargas, (304) 285-4617

An Advanced, Open-Path, Atmospheric Pollution Monitor for Large Areas

Objective

This effort will develop and test a novel thermal emission/laser absorption (TELA)-based instrument capable of long-range (up to 4 kilometers) measurement of atmospheric emissions. The work will be performed in the base contract and two options. In the base contract, the contractor will analyze system performance; develop a detailed design; and fabricate, assemble, and perform laboratory testing of a pre-prototype TELA monitor. In option 1, validation testing of the TELA monitor will be performed at a DOE site. In option 2, the contractor will field test the TELA monitor at the DOE Hanford site.

Progress

This contract ended December 18. Option 1 was not exercised because the Tanks Focus Area could not identify a need for this technology.

PI: Lyle Taylor, Northrop Grumman (Westinghouse), (412) 256-1650

FETC COR: Maria Vargas, (304) 285-4617

Automated Monitoring System for Fluid Level and Density in High-Level Waste Tanks

Objective

This project will develop a real-time continuous monitoring system of waste fluid levels and fluid densities in DOE waste tanks. The system will consist of a string of small piezoelectric elements placed inside an existing liquid observation well (LOW). A small force will be exerted on the tank wall, consequently producing sound waves that will be detected by the piezoelectric elements and multiplexed to provide real-time information on the tank waste fluid level and fluid density. In the base contract, a prototype was designed, fabricated, and tested in the laboratory. In option 1, information gained from the laboratory testing will be used to modify the design to produce a full-scale system that will then be deployed in a LOW for long-term monitoring.

Progress

The contract modification for the option phase of this project was awarded last month to continue development and testing of a fieldable prototype capacitance-based instrument. Science and Engineering Associates is planning an information gathering and coordination meeting at Savannah River to better determine the exact specifications for the level monitors needed for the waste-processing tanks at the site.

FETC and the CMST-CP are also determining if development of the acoustic-based tank-level sensor should also be pursued for the Slurry Mix Evaporator tanks application in the Savannah River Defense Waste Processing Facility (DWPF).

PI: David Cremer, Science and Engineering Associates, (505) 884-2300

FETC COR: Ron Staubly, (304) 285-4991

Waste Retrieval

Ultrasonic Sensors for *In Situ* Monitoring of Physical Properties

Objective

This project will develop ultrasonic sensors for *in situ* monitoring of physical properties of radioactive tank waste. The initial focus is on developing sensors for fluid viscosity and volume-percent of solids measurements. The sensors will apply mainly to waste transport lines for on-line characterization. The task is to examine the feasibility of measuring fluid shear impedance to determine viscosity and of measuring scattering cross-sections of ultrasonic waves to determine solid concentration. The feasibility of the impedance technique is on the issue of low-viscosity (<30 cP) measurement because the technique has been well demonstrated in the high-viscosity (>1,000 cP) range. The concept of determining solid concentration from scattering cross-section measurement is a new approach and requires a thorough study.

Progress

The focus of our FY98 development is on percent solid concentration measurement. Laboratory tests are being conducted at the Argonne National Laboratory solid/liquid slurry facility to determine the optimal sensing geometry and operating frequency. The technical approach is based on ultrasonic attenuation measurement.

PI: Shuh-Haw Sheen, Argonne National Laboratory, (630) 252-7502

Comparative Testing of Pipeline Slurry Monitors (Oak Ridge National Laboratory)

Objective

This project will demonstrate, test, and evaluate slurry monitoring instruments that are commercially available and those being developed for the CMST-CP, the Tanks Focus Area (TFA), and the Oak Ridge National Laboratory (ORNL) Waste Management organization (an EM-30 entity).

Progress

Comments received regarding the draft report for FY97 activities are still being incorporated into the report. The instrument developers and commercial manufacturers were requested to provide a response to our report. This response is an opportunity for the instrument developers to evaluate the data in the report and to provide their perspective about their instruments' performance. The responses will be included in the final report.

The design specification for the test loop for the FY98 activities was completed. The design will be sent for bids to fabricate the system. The test system includes three vertical upflow legs in which the instrumentation will be installed. Official notification about which instruments the CMST selected for further evaluation has not been received, but the test system was designed so any of the candidate instruments can be incorporated.

Preparation of the test plan for FY98 activities started.

PI: Tom Hylton, Oak Ridge National Laboratory, (423) 576-2225

Waste Sampling/Analysis

Field Raman Spectrograph for Environmental Analysis

Objective

This effort will design, fabricate, field test, and evaluate a field-hardened Raman spectrograph/monochromator system including its analytical protocols. The technical goal is a field-portable, fiber-optic Raman spectrograph that can be used to obtain chemical fingerprints of hazardous wastes in storage tanks and of concentrated and diluted environmental contaminants in soil and water.

With enhanced Raman techniques, the spectrograph/monochromator system should be suitable to detect Raman spectra from highly concentrated materials and for parts-per-billion levels of materials. The system will be used to identify a wide variety of wastes and pollutants in storage tanks, soils, and ground and surface waters at DOE sites.

Continued

Progress

The contract completion date was extended to March 31 because of the nonavailability of the appropriate equipment and DOE resources for demonstration at the Savannah River Site.

PI: Michael Carrabba, EIC Laboratories, (617) 769-9450

FETC COR: Jagdish Malhotra, (304) 285-4053

Process Monitoring

Development of Process Monitors for Cesium-137 Column Breakthrough

Objective

This project will optimize an inexpensive, highly reliable, near real-time monitoring system for the specific detection of ^{137}Cs in the effluent from an ion exchange column. A matched pair of radiation detectors will be used to monitor activity in the effluent stream at two locations separated by a short span of time.

Progress

This month, software development for data acquisition/reduction continued. The count rate software module was written, tested, and accepted. This portion of the software is designed to permit both upper and lower limits on the data acquisition rate to be set based on the type of detectors, statistical requirements, etc., to measure the actual data acquisition rate on a continuous basis, and to call for adjustments to the rate when the limits are exceeded. The collimator control software module was also written and tested with surrogate collimators. This portion of the software is designed to drive the controller motor on the adjustable collimators in response to the needs of the count rate module. If the count rate falls below the minimum set point, the collimators will open to the next calibrated position, thus allowing more events to be incident on the detectors; conversely, the collimators will close if the count rate exceeds the maximum acceptable set point.

PI: Ron Brodzinski, Pacific Northwest National Laboratory, (509) 376-3529

Development of a Magnetic Resonance Monitor for Technetium-99 Column Breakthrough

Objective

This task will develop and implement a real-time, on-line monitoring system for ^{99}Tc. This system will be based on magnetic resonance spectroscopy of the ^{99}Tc nucleus. The sensor will be based on the Argonne National Laboratory (ANL) on-line, flow-through magnetic resonance sensor technology that is being developed for on-line sensing and quantification of organic components.

The spectrometer will incorporate a permanent magnet, a highly miniaturized electronic package, an intelligent operating system, a remote setup and operation panel, and be completely enclosed in a short 19-inch National Electrical Manufacturers Association (NEMA) 4 instrument rack. This technique will provide a real-time (milliseconds), nonradiometric sensing method capable of operating in a high-radiation environment, with immunity to contaminants, on high-pH solutions, and in high dissolved salt levels. In addition to the areas of tank waste processing, this sensor system will prove valuable in other waste processing technologies.

Progress

We initiated several nuclear magnetic resonance (NMR) studies on a prototype, in-plant 2.05 Tesla permanent magnet system. Operating just above room temperature, this magnet is particularly advantageous for in-plant operations because it requires minimal maintenance while providing reasonable magnetic field homogeneity. Experiments were performed on specimens in 5-mm-diameter NMR tubes with an active volume of 0.2 ml. Additionally, these studies were performed using protocols that require a maximum of 14 minutes per analysis. Initial results demonstrated that it is possible to monitor pertechnetate species from high concentrations to a lower detection threshold of 100 micromoles/l (167 μCi/l). This sensitivity is already sufficient to ensure a minimal detection limit well below the Class A disposal limit of 0.3 Ci/m^3 (for ^{99}Tc, this equates to a concentration of 178 micromolar). Additional improvements in the instrumentation to reduce the minimal detection threshold are in progress. Such improvements include increasing the sample volume and replacing select electronic components with components that are less noisy. Further analysis will be performed next month.

We are completing arrangements (i.e., safety protocol write-ups and inspections) required to perform a series of oxidation and reduction reactions on the technetium specimens. Initial plans include reduction of pertechnetate-containing solutions using bisulfite followed by subsequent oxidation of the reduced Tc mixture back to pertechnetate using the silver/persulfate reagents. The oxidation was recently demonstrated by Norm Schroeder, Los Alamos National Laboratory, to be quite effective in the oxidation of Tc to pertechnetate in task waste specimens. Studies will be performed at various temperatures; the reaction will be monitored via NMR to measure kinetics.

PI: Stephen Dieckman, Argonne National Laboratory, (630) 252-5628

Mixed Wastes

Pre-Processing Characterization/Monitoring

Waste Inspection Tomography

Objective

This project will construct a transportable inspection system to characterize containers of radioactive waste by nondestructive evaluation and assay. The Waste Inspection Tomography (WIT) system is contained in a semitrailer that could be driven to various DOE sites. Containers of waste at these sites would be imaged and the radioactive components analyzed without opening or physically sampling the containers. The purpose of the system is to allow rapid, cost-effective reduction of the backlog of radioactive waste containers by characterizing them as safe for storage at approved underground sites, or else by determining if additional treatment is required before such storage. The development effort will involve integration of two forms of computed tomography, transmission and emission.

Progress

A preliminary kickoff meeting was held this month for WIT upgrades at Bio-Imaging Research (BIR). Attendees of the two-day meeting included Pat Roberson, Lawrence Livermore National Laboratory (LLNL); Dave Camp, a BIR Physicist consultant from Danville, California; Steve Cooke, FETC (Morgantown); and Dick Bernardi, Ken Hill, and Dave Entwistle of BIR. The meeting consisted of a design review and planning for the multiple active and passive computed tomography (A&PCT) detector upgrade. Recommendations for detector and isotopic source purchasing were made. Based on a preliminary layout of the WIT scanner gantry and its space and weight limitations, recommendations for detectors and for scanner geometry with collimation and shielding for both the sources were made. New drive axis requirements were also specified. Software tasks and a schedule of 1998 activities were discussed. We expect to have all software design descriptions available for review by late August. The software effort is the most labor intensive effort of the program, with four new software modules to be developed. These include motion control, data collection, preprocessing, and reconstruction. In addition, automated spectroscopy as well as calibration methods (for system validation) are to be defined and developed.

Long lead items include the custom cryogenic dewar, with 18 weeks from order to delivery. Several related activities are complicating the schedule for this project: the Carlsbad Area Office (CAO) audit of the WIT trailer in March and the WIT inspection of 800 drums for both nondestructive evaluation and assay (NDE/NDA) at the Nevada Test Site (NTS) in April and May. Installation of the new HPGe detectors and isotopic sources is to take place at BIR in late June. Testing of the multiple A&PCT system at LLNL is expected in July and August, and a CAO audit of multiple detector A&PCT is

scheduled at LLNL in late August. Our plan is to have this contract (WIT upgrade) completed by September. WIT NDA of the 800 NTS drums with the new multiple A&PCT detectors is expected in September and beyond at the NTS. The WIT trailer will be moving around this year.

Following the design review, BIR and LLNL personnel traveled to EG&G Ortec in Oak Ridge for a one-day meeting to review the detector system from the preferred vendor for this WIT upgrade. During the past year, BIR acquired quotations for Ortec, Canberra, Oxford, and Eurysis Mesures for the purchase of these new detectors. The current vendor selection is Ortec based on a combination of price, compatibility, and technology advantages. EG&G has the most favorable pricing, is compatible with current WIT and LLNL systems, and offers a digital DAS that can be computer networked—all of which are advantages over the competition. The meeting taught BIR how to interface the WIT computer systems to the Ortec DAS and confirmed the preferred WIT system geometry of the multiple detector configuration.

Finally, DOE negotiations of this contract modification to achieve the implementation of this upgrade continued. It is hoped that the contract modification will be in place by early January. The DOE provided interim funding so we could hold the two meetings described above to set the schedule and plan the year.

Unrelated to the project activities above, but important to the future of WIT, DOE reports were issued from Greg Becker at Idaho National Engineering and Environmental Laboratory (INEEL) and Don Galbraith of the CAO regarding the Capability Evaluation Program and the Performance Demonstration Program (PDP) results, respectively, for WIT blind assay testing in October 1997 at INEEL. WIT passed precision and accuracy tests on all drums assayed with A&PCT. These include leached metals, MSE salts, sludge, Raschig rings, combustibles, and zero matrix drums. BIR received a letter from the DOE CAO that as of December 18, WIT was approved by the CAO for NDA of TRU waste drums using A&PCT based on cycle 4 testing of the PDP.

PI: Richard Bernardi, Bio-Imaging Research, (847) 634-6425

FETC COR: Steve Cooke, (304) 285-5437

Nondestructive Examination and Assay of Drums Containing Transuranic Waste

Objective

This project will develop and integrate techniques for nondestructive examination and assay of drums containing transuranic (TRU) waste. The data output from the integrated system, consisting of X-ray, gamma-ray, and neutron interrogation methods, will be combined using computer data fusion techniques. The X-ray and gamma-ray

inspection modalities are provided by the Waste Inspection Tomography (WIT) system developed under a separate DOE contract; neutron inspection will be provided by the Active Passive Neutron Examination Assay (APNEA) system, developed by Lockheed Martin Specialty Components. The integrated system will provide identification of the waste matrix and its density distribution; location of gamma emitters and fissionable components; identification of isotopes; TRU waste localization; and total TRU waste quantification. An imaging computer interface will be developed for data fusion and presentation in a manner consistent with the Waste Isolation Pilot Plant Waste Acceptance Criteria and the Quality Assurance Program Plan.

Progress

Lawrence Livermore National Laboratory (LLNL) continued to perform spectroscopy and active and passive computed tomography (A&PCT) assay on a voxel-by-voxel basis on the eight Rapid Commercialization Initiative (RCI) drums.

Specifically, LLNL will provide the following information:

- *Mass attenuation coefficient by voxel based on the percent of drum weight.* Calculation will be performed as follows: (linear attenuation coefficient for each voxel / total linear attenuation coefficient) * (gross weight of drum).
- *Total ^{239}Pu by voxel.* This will be determined as follows: total count in each voxel / (integration time * detector efficiency * branching ratio * specific activity * 3.7E10 disintegrations per second).
- *Total Pu by voxel.* This will be determined by weighting the ^{239}Pu by the Pu isotopics obtained from "spectroscopy analysis."
- *Total ^{241}Am by voxel.* This will be determined by weighting the ^{239}Pu by the isotopics for americium obtained from "spectroscopy analysis."
- *Total ^{235}U by voxel.* This will be determined by weighting the ^{239}Pu by the isotopics for uranium obtained from "spectroscopy analysis."

This data will be presented in A&PCT voxel format, i.e., each slice will contain 14 x 14 voxels. LLNL expects to complete this work by February 6.

Bio-Imaging Research (BIR) is modeling the 3D volume to convert the 14 x 14 x 18 pixel matrix of WIT A&PCT to mimic the 56-pixel (voxel) volume (6 slices with 9 pixels per slice) matrix of APNEA. We expect this BIR effort to be done within one week of this report.

TRUtech is preparing to provide BIR with a voxel-by-voxel isotopic breakdown (56 voxels per drum) of all six common RCI drums from APNEA. BIR does not have a date from the APNEA team as to when these data will be available. BIR had hoped to supply a summary of results in a draft final report by January, but that seems unlikely without the APNEA data. Next month, integration of data on a drum-by-drum basis to begin to analyze the benefits of WIT/APNEA data integration should begin.

The expected outcome of this work should lead to a recommended procedure of analysis that will lead to the ability to both validate each technique's finding and improve one or the other system's results either in the form of accuracy or performance improvements in assay.

PI: Donald Robertson, Bio-Imaging Research, (847) 634-6425

FETC COR: Steve Cooke, (304) 285-5437

DOE Laboratory/Industry Performance Demonstration Test

Objective

To facilitate the characterization of waste drums at DOE sites and to determine if additional nondestructive evaluation/nondestructive assay (NDE/NDA) technical development is needed, it will be necessary to establish the performance capabilities of the NDE/NDA technologies that will make those characterization measurements.

To accomplish this objective, a series of performance demonstration measurements will be conducted at Idaho National Engineering and Environmental Laboratory (INEEL) with selected participating technology holders. The results will be used to prepare two reports, one for EM-30 to use for equipment selection decisions and the other for EM-50 to determine the amount, if any, of additional development efforts to fund.

Progress

Cycle 2 evaluation began this month. Canberra's High Efficiency Neutron Counter (HENC) was calibrated and operated to perform preliminary baseline measurements. About half way through the month, HENC received its first test sample. By the end of the month, HENC had completed about a third of the test samples. HENC will complete the evaluation during the third week in January.

The Canberra IQ3 system did not arrive as scheduled on December 8 because of snow in the Denver area and a shortage of trucking resources in the Rocky Flats area. The system arrived about two weeks late.

Because the Segmented Gamma Scanner performed poorly in the first cycle (see comments below), Canberra elected to use more intense calibration sources to ensure success of the IQ3. Three 5 R Europium sources were shipped to INEEL. Because of faulty packing, one source fell out of the packing container during shipment. This resulted in the issue of an Unusual Occurrence Report, notification of the Secretary of Energy, and a Nuclear Regulatory Commission and Federal Express investigation. Although the lost source was ultimately located inside the transport truck, one calibration source was severely damaged. IQ3 will not be able to begin calibration for about a month because of the delay of shipping a new source.

Cycle 1 surrogate sample results reported by each participant were examined and scored. Scoring these results involved the exact determination of all decayed concentrations of species in each source used in the makeup of each surrogate. After the exact concentration was determined, the uncertainty allowance values presented in the Waste Isolation Pilot Plant Quality Assurance Plan, Section 9, were applied. This resulted in generation of an upper and lower boundary value. Participant assay results were examined to see if the reported value fell inside or outside the boundary values.

The Bio-Imaging Research Waste Inspection Tomography (WIT) system examined a total of four test samples. Two samples were surrogates. WIT correctly analyzed both of these surrogates or the reported average value fell within the boundary values. However, one sample contained a sizable amount of plutonium. WIT does not have the ability to determine sample isotopic content. Therefore, an assumption was made to assign nominal values for weapons grade Pu. The combination of the amount of Pu in the sample and the ensuing wide boundary values resulted in the reported value just falling within the acceptable value. Had the sample contained less Pu, WIT would have incorrectly analyzed this sample.

Canberra's Segmented Gamma Scanner (SGS) was able to assay all the test samples within the allotted six-week period. Preliminary scoring of the surrogate drum assay results indicated that the SGS system incorrectly assayed moderate to high-density matrix materials. Because about 60% of the samples in the evaluation are moderate to high density, SGS fell outside the limits for seven out of 11 surrogates. After review of the reported individual measurement values, one reason for the high number of unacceptable results appeared to be a systematic problem that occurred about every eight measurements. Assay values determined during one of these systematic problems were about a factor of 2 to an order of magnitude different from other measurements. Had Canberra elected not to include these data values, they would have correctly assayed 10 out of 11 surrogates.

PI: Mike McIlwain, Idaho National Engineering and Environmental Laboratory, (208) 526-8130

Intelligent Inspection and Survey Robot

Objective

This project will develop and demonstrate a semi-autonomous vehicle to inspect drums or other containers stacked in rows in central storage facilities. The Autonomous Robotic Inspection Experimental System (ARIES) will autonomously enter and trace an inspection route while actively avoiding obstacles. A camera vision system will be used

to assist in the inspection of drums and other containers. The vehicle will be designed to meet the operating environment constraints associated with typical mixed waste storage facilities.

In phase 1, the ability of a testbed robot subsystem to navigate and observe visual damage in a simulated drum storage area was developed and tested. Phase 2 involved integrating subsystems into a robot that can inspect drums while navigating through 36-inch-wide aisles. Phase 3, in progress, involves demonstrating a refined commercial unit at one or more drum storage facilities.

Progress

The contract was extended until July 31. Cybermotion is working to revise the milestones and schedule for both ARIES systems. At present, the ARIES II system is being returned from Los Alamos National Laboratory (LANL). Work on ARIES I proceeded slowly because of holiday and vacation schedules. In the meantime, Cybermotion is assessing the performance of the ARIES II based on the test results at LANL. The Mixed Waste Focus Area has to make a decision regarding the disposition of the ARIES II, as LANL is not interested in the system now.

PI: Robert Pettus, South Carolina Universities Research and Education Foundation, (864) 777-9569

METC COR: Vijendra Kothari, (304) 285-4579

Waste Process Monitoring and Controls

Real-Time Plutonium Monitoring

Objective

This project will develop a molten glass stream on-line, real-time monitor for quantifying the concentrations of transuranics and selected other metals produced by vitrification. The monitor will be based on thermal emission spectroscopy, a nondestructive, non-contact Infrared Spectroscopy (IR) technique that can be used to chemically analyze moving process streams. Preliminary tests in FY97 on a glass melter at Savannah River Site (SRS) showed that the monitor could measure the concentration of ytterbium, a spectroscopic surrogate for plutonium and americium. Savannah River has endorsed production of such a monitor. Starting in FY98, work will begin with a new end-user group at SRS, the Am-Cm Stabilization Project. The monitor will be used to measure americium, curium, and possibly certain other components in the glass stream produced by their stabilization line, which is expected

to go into production in FY00. During FY98, a basic monitor system tailored to the Am-Cm Stabilization need will be built and demonstrated at SRS for the stabilization project staff during some of the prototype testing they plan for this year.

Progress

We continue to gather information from our new end-user group at Savannah River, the Am-Cm Stabilization Project. Their plans are still changing as they discover and solve various equipment and process problems. Therefore, we will likely to need to modify our monitor as their project evolves. Nevertheless, we are purchasing and designing parts of the monitor based on their present information.

PI: John McClelland, Ames Laboratory, (515) 294-7948

Offgas and Effluent Monitoring

Development of a Multielement Metal Continuous Emissions Monitor

Objective

This project will combine the air - inductively coupled plasma (ICP) atomic emission continuous emissions monitor (CEM) being developed at Diagnostic Instrumentation and Analysis Laboratory (DIAL), Mississippi State University (MSU), with the High Resolution Interferometric Spectrometer (HiRIS) being developed by Ames Laboratory. The HiRIS was developed for monitoring the isotopic composition of actinides, providing the resolution and sensitivity of a 1.5-meter spectrometer in a much smaller, lighter, and cheaper device. This project will (a) assemble a version of this device, incorporating components for ultraviolet operation, for detection of EPA-regulated metals, (b) integrate it into the DIAL CEM, and (c) demonstrate the system, with the DIAL developer, at a test facility. The HiRIS is completely electronically tunable and will be equipped with extensive software control and analysis routines to enable sensitive and accurate calibration and continuous monitoring.

Progress

We are continuing bench testing using a photodiode array detector and are incorporating this device into our software control system for rapid multielement detection.

We discussed the alpha-emitter CEM test planned for later this fiscal year with our program facilitator.

We received reprints of our article, "Limits of Detection for an AOTF-FFP Spectrometer in ICP Atomic Emission Spectroscopy," which appeared in the December 1997 issue of *Talanta*.

PI: David Baldwin, Ames Laboratory, (515) 294-4748, dbaldwin@ameslab.gov

Metal Emissions Monitor for DOE Mixed Waste Thermal Treatment

Objective

This task will develop and demonstrate an instrument using laser-spark-emission spectroscopy (LASS) as a continuous monitor to measure metal emissions from offgas of thermal treatment units. The project will address several important issues for the instrument, including sensitivity (at ppb concentrations for metals governed under the clean air act), calibration, durability, reliability, and accuracy. The purpose of this development is to design, build, and test a field instrument at a DOE facility.

Progress

The December 1997 field test at the glass furnace provided a useful test of a new fully automated data acquisition package. Alkali, alkaline earth, and main transition metal species were targeted in the exhaust stack. Real-time measurements of sodium, calcium, magnesium, strontium, silicon, and iron were recorded using both time-averaging and single-particle detection.

The data generated during the September 1997 EPA Incinerator field test were fully analyzed. Comparison of LIBS-based concentration values with Method 29 results revealed an average agreement within 37% for cadmium, chromium, iron, and yttrium. The beryllium values were about 60% lower than the Method 29 results. These values reflect an adjustment that was introduced to correct for a detector timing malfunction that was identified after the test. The timing problem was reported and documented before the release of the reference method data. A formal report was completed and forwarded to the CEM test committee for inclusion in the final test report.

An alternative lead atomic emission line was investigated in the laboratory that yielded significant improvements in the lower detection limits of the LIBS instrument. The new line is the Pb I line at 405.78 nm, which yields detection limits of approximately 25 to 30 micrograms/actual cubic meter, as compared to a detection limit of about 400 micrograms/actual cubic meter using the 220.4 nm Pb II emission line.

PI: David Hahn, Sandia National Laboratories, (510) 294-3337, dwhahn@sandia.gov

Disposition of Facilities (D&D)

Surfaces

Three-Dimensional Integrated Characterization and Archiving System

Objective

This project will develop an integrated system that remotely characterizes, maps, and archives measurement data of hazardous D&D areas. The system will generate a detailed 3D topography of the area and real-time quantitative measurements of volatile organics and radionuclides. The system will analyze substrate materials consisting of concrete, asbestos, and transite, and will permanently archive data measurements for regulatory and data integrity documentation.

The objectives will be completed in three phases. In phase 1, Coleman Research Corp. demonstrated the Coherent Laser Radar (CLR) mapping capabilities (0.5 mm resolution over a 15 m range) in the laboratory, along with the ability of the high-speed gas chromatograph (GC) to resolve more than 200 peaks in less than 30 seconds. In phase 2, Coleman developed, integrated, and demonstrated the subsystem components to form the 3D Characterization and Archiving System (3D-ICAS). In phase 3, this effort will integrate all the subcomponents and demonstrate the capability of the system at the Oak Ridge National Laboratory (ORNL) site, as well as to demonstrate a fully integrated 3D-ICAS at Maturity Level V.

Progress

The final report and several required property reports were completed and delivered.

PI: Ray Ross, Coleman Research Corporation, (703) 719-9200

FETC COR: Vijendra P. Kothari, (304) 285-4579

Metals and Pipes

Portable X-Ray, K-Edge Heavy Metal Detector

Objective

This work will develop improved nondestructive assay (NDA) techniques for detecting and quantifying uranium, plutonium, and other heavy metals. The work will focus on situations where these elements are located inside sealed containers or processing equipment. The approach to this problem is based on observing the K-edge absorption

transition in X-ray transmission measurements. The technique will be developed to maximize sensitivity for detecting heavy metals, while minimizing measurement time.

Progress

This month, further discussions were held with Trent Andes of Westinghouse Savannah River Company, where characteristics of spent nuclear fuel must be verified for long-term storage of the fuel. When Mr. Andes is at Iowa State University on other business in mid-January, he plans to view a demonstration of the K-edge system.

Discussions were initiated with Bob Gehrke and Mike Connolly of Idaho National Engineering and Environmental Laboratory regarding Resource Conservation and Recovery Act (RCRA) metals characterization in sludge. They developed a set of phantom drums containing known concentrations of Hg, Pb, and Cd in concrete. Arrangements are being made to obtain a set of these drums for evaluation of the K-edge inspection technique.

On December 4, PI Terry Jensen attended workshops on decontamination and decommissioning needs at gaseous diffusion facilities and plutonium processing facilities during the X-Change '97 conference in Miami. Information on K-edge technology was presented to workshop participants, and potential new applications in characterizing glove boxes at Rocky Flats Environmental Technology Site were identified.

PI: Joe Gray and Terry Jensen, Ames Laboratory, (515) 294-9745

Characterization of Radioactive Contamination Inside Pipes with the Pipe Explorer™ System

Objective

In phase 1, the inverting membrane deployment technology (developed for sensor deployment in boreholes as the SEAMIST™) was integrated with off-the-shelf gamma radiation detectors to characterize small- and large-diameter piping configurations similar to those at DOE sites. In the laboratory, the Pipe Explorer™ System was capable of negotiating multiple elbows in 2-inch-diameter pipes and larger while detecting gamma sources down to 1,000 dpm/100 cm^2 surface activity. Piping networks up to 200-feet long were characterized. The system was also field tested at Idaho National Engineering and Environmental Laboratory (INEEL), where it characterized scrap pipes of different diameters and a mock-up of a contaminated drain line. In phase 2, the phase 1 system will be modified for autonomous operation and redesigned (as required) in preparation for extended field demonstrations in actual piping systems at the DOE site(s).

Progress

Eight surveys were conducted in a total of 350 feet of concrete-embedded piping to determine the adequacy of cleaning. The Pipe Explorer™ was able to track the cleaning effectiveness of the high-pressure water system. It was able to identify piping systems that are suitable for free release without excavation and piping systems that require further cleaning or excavation for disposal as low-level radioactive waste. The use of the Pipe Explorer™ saved Pacific Gas and Electric (PG&E) money by free releasing a portion of the piping system and avoiding the costly excavation of pipe. The PG&E surveys represent the second time that the Pipe Explorer™ has been commercially deployed outside of the DOE weapons complex.

PI: David Cremer, Science & Engineering Associates, Inc., (505) 880-9852

FETC COR: Steven Bossart, (304) 285-4643

Associated Particle Imaging

Objective

The Associated Particle Imaging (API) field system will address the radioactive contamination need for active radiological measurements of embedded contaminants. API is a means of characterizing the elemental composition of materials and their shapes in three dimensions even when buried within other structures and accessible for interrogation from only one side.

The project will measure and characterize a customer-defined contaminant deposit at the K25 site in Oak Ridge, Tennessee, using the API system. The mobile API system will be prepared at Special Technologies Laboratory (STL), including procurement, testing, and system integration of a new sealed tube neutron generator (STNG) tube. With support from K25 personnel, the API system will be demonstrated at a location of their choice. Appropriate industry representatives will be invited to the demonstration to introduce the API technology to the commercial sector. The priority target will be observed and applicable data provided to K25 personnel in a summary report.

Progress

The final report is finished and in the final formatting and review process. We have decided to use the small remaining carryover funding to complete a draft final API project report, a detailed survey of the API system and the results of its various application experiments. This additional task will delay completion until late January.

PI: Chuck Hudson, Special Technologies Laboratory, (805) 681-2248

Facility Characterization

Airborne and Ground-Based Laser-Induced Fluorescence

Objective

This project will further develop and test the capability of laser-induced fluorescence imaging (LIFI) techniques for detection of uranium, heavy metals, organic compounds, and vegetation stress. The project's major efforts are: (1) to develop an airborne LIF system for survey of large geographic areas, and (2) to develop a handheld LIF instrument for detection of uranium on surfaces during decontamination and decommissioning (D&D) operations. Specific tasks include (1) handheld uranium survey tool development, (2) support for the Cooperative Research and Development Agreement (CRADA) with Disney/EPCOT Center, and (3) airborne LIF tests and evaluation.

Progress

Airborne system. Diagnostics on the airborne optical system were postponed until January in favor of higher priority work on backpack system development. However, aided by our DOE facilitator (Hippensteel), we contacted the DOE office at Savannah River Site regarding a possible overflight of contaminated sites there sometime this spring. We will continue to work on the details of the airborne flight while diagnosing and upgrading the optical system.

Backpack system. Reductions in the size and weight of the uranium survey tool were constrained in the past by the complexity of integrating multiple OEM components into a single package. In the final version of the system, every effort was made to create the smallest package possible without substantial reengineering of components. Special Technologies Laboratory worked closely with the laser manufacturer to modify their existing product line to create a new laser system that can integrate with our components with little or no modification to the laser packaging. We visited the laser manufacturer in December and discussed the survey tool in detail. Drawings exchanged then formed the basis for our CAD model for the conceptual mechanical design. The backpack portion (which includes everything but the cable and handheld head) will be less than 18 inches tall and weigh approximately 32 pounds.

We reduced the size of the on-board computer system and replaced the camera with a lighter one than previously fielded (2 pounds vs. 9 pounds). The new camera was successfully tested with the new computer.

The miniaturization of the computer system changes the interface to the system timing control board that fires the laser and sets the opening time and duration of the microchannel plate camera shutters. A design review of timing requirements, configurations, and options was performed. Components were defined in an engineering study of system parameters that included power, size, weight, cabling, and ergonomics. In the next fieldable prototype, we will incorporate some form of semi-

automated shutter control; in the final design, the timing control will be completely automated so the system operates seamlessly as the ambient light level changes, such as when moving from room to room during a survey.

PI: John DiBenedetto, Special Technologies Laboratory, (805) 681-2240

Laser-Induced Fluorescence for Heavy Metals in Soils and Plants

Objective

This task will conduct a demonstration of the laser-induced fluorescence imaging (LIFI) technology for the detection of heavy metals in soils and plants in Poland. The handheld LIFI unit will be used to collect data from vegetation of interest within the test study area, as well as from experimental plots to be supplied by the Institute for Ecology of Industrial Areas (IETU) in Poland. The portable survey tool will be prepared (i.e., modified, assembled, and tested) for use in Poland. The Special Technologies Laboratory (STL) team will travel to Poland to take plant fluorescence data in various spectral bands at a chosen field site, and return to STL to analyze the collected data.

Progress

Analysis of the data collected in Poland has been limited to LIF spectroscopy (spectral) data. We first looked qualitatively for the presence of wavelength shifts in the fluorescence peaks. We are making quantitative analyses of intensity changes in the fluorescence peaks, normalized to a single laser pulse, and are searching for variations in band ratios. The results from these analyses will guide our examination of the LIFI (image) data.

Work was slowed because essential personnel were unavailable. Our new goal is to complete the data analysis and write a brief summary report by the end of January.

PI: John DiBenedetto, Special Technologies Laboratory, (805) 681-2240

Plant Stress Analysis Technology Transfer

Objective

In FY98, this project will focus on assessing the needs and potential range of applications of the laser-induced fluorescence imaging (LIFI) technology within the DOE complex. Specifically, the Hemispheric Center for Environmental Technology (HCET) personnel will research the needs of the Subsurface Contaminants Focus Area and will verify those needs with the site users. Several DOE sites will be surveyed,

and a list of subsurface contaminants currently of interest and concern to those sites will be compiled and delivered to Special Technologies Laboratory (STL).

Progress

This month, the Latin American agricultural market survey was completed.

Early in the month, the DOE and Florida International University hosted X-Change '97: The Global D&D Marketplace. During this conference, personnel from HCET and STL met with the DOE program facilitator to discuss the scope of the LIFI project for FY98. A new scope and focus were defined. A new project technical plan was drafted to reflect the redefined scope for December 1997 through October 1998.

PI: M. A. Ebadian, Florida International University, (305) 348-3585

Environmental Remote Sensing for Monitoring Plant Health (EPCOT)

Objective

Optical characteristics of plants are being measured to detect stress as an indicator of underlying problems such as chemical contamination of soil or groundwater at the DOE and other sites. This project will apply the results of those measurements to construction of a robot-mounted suite of remote sensors for greenhouse installation and testing at EPCOT Center in Walt Disney World.

The project will involve a public demonstration of DOE technology; DOE-industry and government interagency cooperation; and technology transfer, i.e., to the agricultural community. The final application of this technology will be remote monitoring of DOE sites for detection of uranium oxides and plant stress monitoring. Vegetational sites include clay caps and landfills, while uranium surveys include monitoring decontamination and decommissioning (D&D) sites.

Progress

The robot-mounted sensor suite is being modified to change the standoff distance from 18 to 24 inches. A new fiber-optic input head was built and tested to provide the desired 3-inch-diameter observation spot at 24-inch standoff. The old unit is still functional and can be used for narrow-field-of-view measurements. Optics are on order for an additional head with a larger field-of-view field required for "canopy" measurements.

The new plant growing system adjacent to the robot arm was installed on December 10. Wheat, pepper, and soybean plants were transplanted several days later. The proposed system for growing the plants is still being tested. We will continue to work with the plant growing system and the robot programming and sensor modifications through January, with the intention of attempting data acquisition at the beginning of February.

The first data take was completed on the second-run bean/zinc experiments. Results were consistent with the first run of the experiment. In general, fluorescence from the 0-ppm zinc-treated plants is 40 to 50% of that from the control plants grown at 0.3 ppm zinc. Secondly, as the concentration of zinc increases, there appears to be a slight increase in fluorescence across the full range of excitation and emission spectra. However, the top zinc level of 40 ppm was not high enough to induce toxic effects. Therefore, a second series of bean/zinc studies is planned for the spring in which the highest zinc level will be 100 to 150 ppm depending on how high a zinc concentration we can achieve and still keep zinc dissolved in the nutrient solution. The merged data from runs one and two are being analyzed.

It has been found that to raise zinc to levels above 5 ppm, a chelating agent is required. However, use of this agent increases the sodium level in the nutrient stream. Given the time and space constraints, the best remedy for future high-zinc experiments will be to run a control group of chelate/sodium plants (i.e., minus the zinc). If no effects are observed with the high chelate/sodium treatment, then we will conclude that observable effects were caused by the elevated zinc levels alone. Otherwise, we must move away from nutrient-solution techniques for these measurements, probably using field soils to which zinc has been added.

The on-site PI at EPCOT (Schuerger) visited his Dynamac colleagues at Kennedy Space Center (KSC) early in December to coordinate the biochemistry and histology procedures planned for the spring zinc and temperature experiments. Both procedures are relatively easy, and the equipment will be set up during January.

The project PI (Capelle) visited Dynamac at KSC on December 1 to meet with Doug Britt, vice-president, and several scientists. Among topics discussed was the potential for application of laser-induced fluorescence imaging (LIFI) techniques (handheld and airborne) to several KSC projects. Capelle attended X-Change '97 in Miami the next two days and made contacts with several organizations interested in the capabilities of the portable LIFI system. He also met with Florida International University people regarding their possible contribution to the EPCOT project.

PI: Gene Capelle, Special Technologies Laboratory, (805) 681-2252

Remote Surveillance of Facilities Awaiting Decontamination and Decommissioning

Objective

This project will develop a remote surveillance system to provide continuous monitoring of facilities and reduce the need for labor-intensive and hazardous surveys. The Hemispheric Center for Environmental Technology (HCET) will research applicable commercially available and OST-developed sensors. Sensors being

developed by the CMST-CP will also be examined for applicability to decontamination and decommissioning (D&D) needs. HCET will perform any required adaptation. In addition, working with its analytical laboratory, HCET will develop system validation procedures based on the performance criteria collaboratively defined by HCET and the D&D Focus Area.

Progress

This project began in November. To date, some of the manufacturers of the sensors—Bicron, Canberra, LND, AIL, SAIL, etc.—were contacted for information about their technologies.

This month, the Site Technology Coordination Group (STCG) databases for the following sites were searched for their needs in the area of remote surveillance and characterization:

- Savannah River
- Los Alamos National Laboratory
- Rocky Flats
- Richland Operations Office/Hanford
- Fernald
- Ohio/Mound
- Oakland Operations Office/Lawrence Livermore National Laboratory
- Nevada
- Idaho Operations Office
- Oak Ridge National Laboratory
- Chicago Operations Office/Princeton Plasma Physics Laboratory

From the 11 sites, a summary of needs for five sites (Savannah River, Los Alamos National Laboratory, Rocky Flats, Richland Operations Office/Hanford, and Fernald) and corresponding contact information was prepared. A detailed list of applicable federal and DOE regulations was also compiled.

In addition to the manufactures/developers previously contacted, information about technologies was obtained from additional manufactures such as SAIC.

PI: M. A. Ebadian, Florida International University, (305) 348-3585

Real-Time Personnel Monitor for Alpha Contamination

Objective

This project will design, calibrate, and test the performance of a personnel alpha contamination monitor based on ion transfer and electret ion chamber (EIC) technologies. The data from the EIC will be transmitted to a remote station on a real-time basis. The unit will be tested at a DOE site, and a commercial unit will be fabricated.

Progress

The project began in November. To date, the design of the personnel chamber to accommodate a standing person was completed, and detailed information about various blowers, motors, and flow controllers for transporting ions to the EIC was collected.

We reviewed the project scope. Based on the need for an automatic, remotely operated, real-time measuring device for personnel alpha contamination, we feel a need to redefine the project.

The measurement of personnel alpha contamination using an EIC is based on the transfer of ions produced by alpha radiation to the electret by flowing air and collection of these ions on the electret surface. The ions collect because of the electrostatic field produced by the electret. As a result of the collection of ions, the surface charge of the electret is reduced. As the electret charge reduces, its sensitivity to radiation also reduces, and below a certain charge the electret must be replaced with a new one. This electret replacement needs to be done manually by an attendant unless an automatic device is developed. Therefore, although the sensor may measure real-time contamination, it may not be automatic or remotely operated. In view of this limitation, it may be necessary to redefine the project scope.

PI: M. A. Ebadian, Florida International University, (305) 348-3585

Process Monitoring

On-Line Measurement of the Progress of Decontamination

Objective

This project focuses on in-process characterization during decontamination and decommissioning (D&D) operations. The specific aim is to develop and demonstrate techniques to monitor radiation levels of treated surfaces and of material removed during concrete decontamination. A key objective is to adapt an existing decontamination technology with commercially available characterization technologies to develop a prototype instrument that will be assessed and then commercially

deployed. A closed-system decontamination technology that uses a vacuum or contaminant collection system will be selected and integrated with appropriate radiation sensing devices and data collection components. This integration of technologies will yield an improved instrument that may be continuously operated, removing contaminated materials and simultaneously assessing the removal progress. The FY98 focus will be selection of suitable commercially available instruments and their calibration using standard sources.

Progress

This project began in November. Initial tasks were (1) generation of a requirements document, (2) review and compilation of decontamination technologies previously tested at the Hemispheric Center for Environmental Technology (HCET), and (3) compilation of information on commercially available radiation sensors. These activities are designed to provide a baseline for the integration work to follow.

This month, work continued with an in-depth search for end users of the integrated technology that will be generated. This search was delineated as phase 1 and involved using currently available information to identify DOE-specified needs that could be fulfilled by completion of the project. Specifically, Internet pages and publications were searched for information both on DOE needs and the contaminants (radioactive components) associated with them.

An Access database and report were generated, with a final listing of 12 needs statements applicable to this project. Several directories were also created to house Internet pages relating to DOE needs, technology transfer, DOE laboratories, and miscellaneous subjects. The directories were then placed in a shared area within the HCET Intranet so CMST-CP members can also use the resources discovered and remain consistent and united in their approach.

Evaluation of both HCET-tested and non-HCET-tested decontamination technologies continued. Investigative work on the radiation sensors also continued through the previous approaches, and also through a networking approach at the X-Change '97 conference in early December. Several promising leads were generated and subsequently followed-up.

PI: M. A. Ebadian, Florida International University, (305) 348-3585

Program Coordination

Characterization Crosscutting Program Field Coordination

Objective

This project provides field coordination and program support for Characterization, Monitoring, and Sensor Technology Crosscutting Program (CMST-CP) activities. It involves and contributes to identification of technology needs; assessment of technology requirements, capabilities, and limitations; promotion of technology integration; assessment of technology development opportunities; and program planning and implementation.

Progress

CMST FY98 multi-year program plan (MYPP). All CMST team members worked together to complete the MYPP document, which was submitted to DOE Headquarters (HQ) on December 31. The MYPP contains information regarding the program's purpose, Focus Area mission, work scope, performance metrics, and program execution, including key accomplishments in FY97 and major activities for FY98 through FY06.

FY98 CMST-CP kickoff meeting. Team members prepared information regarding the projects they facilitate for presentation at the CMST-CP kickoff meeting scheduled for January 6 and 7 in Las Vegas. Paul Wang prepared a presentation regarding the program, including information about facilitator roles, responsibilities, and duties, Site Technology Coordination Group (STCG) needs assessment and needs prioritization, the CMST gap analysis report, and the multi-year program plan.

Cost savings reports. Stephan Weeks continued to coordinate an effort to provide funding for work at Pantex to obtain valuable and accurate cost savings data for the development of the Innovative Technology Summary Report. He also continued discussions regarding Digface (alias Warthog).

Support for program management:

- Dave Roelant, PAI, collected information about 10 CMST-CP technologies and submitted slides on those technologies, along with slides on two additional technologies, for inclusion in the FY97 Annual Report to Congress for DOE/ EM-50.
- Weeks submitted drafts of Technology Summary Sheets for his FY98 facilitator projects.
- Roelant completed analysis of performance metrics for the CMST-CP for FY94 and FY95.

- Wang prepared information regarding three CMST-CP projects for use by Dave Hippensteel, CMST-CP field program manager, at the CMST-CP kickoff meeting in January.
- Roelant conducted a final edit of the Program Baseline Summary (PBS) document for the CMST-CP submitted last month to the DOE HQ.
- Roelant reviewed a letter to be sent from the DOE Nevada Operations Office to the Deputy Assistant Secretary for Science and Technology at the DOE HQ on the effectiveness of the STCGs and improved methods for deploying technologies.
- Weeks reviewed the STCG needs concerning the CMST that are currently available via the Internet. Roelant contacted members of STCGs regarding characterization needs at their sites. Roelant and the Ohio STCG discussed characterization needs at their silo sites; discussions involved a personnel monitor for airborne alpha-emitting radionuclides as well as updating their need priorities.
- Roelant reviewed the open Request for Proposals for environmental technology development under the Department of Defense led (multiple federal agencies) Strategy Environmental Research and Development Program (SERDP). The DOE is a participating agency in the program.
- Roelant collected information on decontamination and decommissioning plans for nuclear facilities and technology development needs at DOE sites. He also collected information on monitoring needs of the Plutonium and Spent Nuclear Fuel Programs at DOE sites.
- As directed by Wang, Weeks worked on developing 'white paper' research ideas relevant to the CMST-CP effort to be performed during the remainder of FY98.
- Weeks met with Hippensteel to discuss CMST-CP activities at Special Technologies Laboratory (STL). He also met with Ed Hohman, Bechtel Nevada (BN) EM Project Engineering Supervisor, and Trey Johnston, BN Business Strategic Development, to discuss CMST-CP activities at STL.
- Team members participated in the CMST-CP team conference calls as directed.

Support for defining requirements for evaluation and testing of radiological sensor and robotic platform techniques. Paul Hurley presented a paper to the National Academy of Sciences on the subject of "Using a Cone Penetrometer/Gamma Probe for Measurements at DOE Sites."

Facilitator activities. In his role as facilitator for the project entitled "Process Monitoring and Control: Ammonia Measurements in Offgases," Weeks contacted Dan Lambert at Savannah River Site concerning implementation of tunable diode laser (TDL)-near infrared (NIR) technology—the Defense Waste Processing Facility (DWPF) waste processing pilot plant is scheduled to be completed this spring. This project's CMST-CP funding ended September 30.

Transition. Effective January 1, Wang will continue to serve as the CMST-CP field coordinator from Concurrent Technologies Corporation, a non-profit organization in Pittsburgh. Little change regarding the CMST-CP field coordination support activities is expected as a result of this move. Wang's new contact information is as follows:

Concurrent Technologies Corporation
320 William Pitt Way
Pittsburgh, PA 15238
Tel: (412) 826-5320 ext. 243
Fax: (412) 826-5552
Email: wangp@ctc.com

Meeting activities:

- Roelant began preparing information for a panel discussion he will participate in at the Nevada Science and Technology Symposium, January 8 and 9.
- Weeks accepted an invitation to arrange and chair a session at the SPIE (The International Society for Optical Engineering) Conference on Environmental & Industrial Monitoring Technologies, November 1 to 6, 1998, in Boston.

Hardcopy and electronic publications:

- Tiffany Zachry, PAI, and Weeks prepared the November CMST Monthly Progress Report with selected highlights and distributed hardcopies to DOE managers and other interested parties. The report was also posted on the CMST Internet site (www.cmst.org) by Krell Institute.

  A new feature that allows users to obtain a report containing progress for a project over an extended time period is now available on the Reports & Publications page under the CMST Monthly Report options.
- Wang submitted an extended summary entitled "Sensor Technologies for Environmental Applications at DOE Sites" for publication in the Proceedings of Nevada Science and Technology Symposium. The summary provides an overview of the CMST-CP program and presents highlights of the program's accomplishments, activities, and future focus areas with particular relevance to the Nevada Test Site. Wang also prepared two summaries for submission to Spectrum '98: "Evolution of Characterization and Monitoring Technologies for Groundwater and Soil" by Wang and "A Streamlined Process for Facility Characterization" by Wang, Mitchell Erickson of Environmental Measurements Laboratory, and Holmer Dugger of ICF Kaiser International.
- Zachry submitted highlights regarding CMST-related activities for consideration of inclusion in the OST Weekly Highlights publication.

PI: Paul Wang, Concurrent Technologies Corporation, (412) 826-5320 ext. 243

Characterization Crosscutting Program Technical Support

Objective

This task provides technical support and assistance in field coordination and program support for the Characterization, Monitoring, and Sensor Technology Crosscutting Program (CMST-CP). It involves and contributes to identification of technology needs; assessment of technology requirements, capabilities, and limitations; promotion of technology integration; assessment of technology development opportunities; and program planning and implementation. Bill Haas and Glenn Bastiaans work as members of the combined DOE Headquarters (HQ) and field CMST-CP management and implementation team, providing technical and other support, as directed, to the CMST-CP HQ Program Manager and the CMST-CP Program Coordinator.

Progress

CMST-CP technical support to the Mixed Waste Focus Area (MWFA):

- *April 1996 performance testing of multi-metals continuous emissions monitors (CEMs).* Bill Haas arranged for the final report, "Performance Testing of Multi-Metal Continuous Emissions Monitors," to be published on the MWFA Internet site. Haas also distributed 54 printed copies of the report by mail.
- *September 1997 multi-metals CEMs test at the EPA Research Triangle Park (RTP).* Haas reviewed the draft report prepared by Nina Bergan French. Haas provided constructive written comments and suggestions to Dr. French and the other members of the CEM working group on December 24.
- *Developer reports on September 1997 multi-metals CEMs test at the EPA RTP.* Haas reviewed draft developer reports on this testing and provided constructive written comments and suggestions on December 29 and 31 to the lead developer authors for the individual monitors and to Nina Bergan French, lead author for the overall report. The reports reviewed were: (1) "A Spark-Induced Breakdown Spectroscopy Based Continuous Emissions Monitor for Lead and Chromium," by Amy J. R. Hunter et al, Physical Sciences Inc., and (2) "Microwave Plasma Continuous Emissions Monitor," by Paul P. Woskov et al, Massachusetts Institute of Technology.
- *Cl_2 and HCl monitors/sensors.* At the request of Andrea Chambers, Lockheed Martin Idaho Technologies Co. (LMITCO), Haas collected and forwarded written information concerning six commercial suppliers of Cl_2 and HCl monitors/sensors for potential application at the Idaho National Engineering and Environmental Laboratory Waste Experimental Reduction Facility incinerator on December 2.
- *X-ray, K-edge absorption spectrometry.* Haas connected Terry Jensen, Ames Laboratory PI of this CMST-CP project, with Mike Connolly and Bob Gehrke, LMITCO, on December 8. The latter are interested in evaluating the performance of the X-ray, K-edge method for nondestructive assay of Resource Conservation and Recovery Act (RCRA) metals in drums.

- *Mercury monitors.* At the request of Ron Staubly, FETC CMST-CP liaison, Haas provided him with information regarding the current status of commercially available and developmental mercury CEMs on December 17. Staubly was preparing for a kickoff meeting in Morgantown, West Virginia, for the Sensor Research, Inc., mercury CEM project.

CMST-CP technical support to the Tanks Focus Area (TFA). On December 17, Bastiaans, in his role as facilitator, and Tom Thomas, CMST lead for the TFA, visited Shuh-Haw Sheen, Argonne National Laboratory PI for the project "Ultrasonic Sensors for *In Situ* Monitoring of Physical Properties." Sheen is developing a system to monitor the percent solids by volume present in tank waste slurries. The purpose of the visit was to determine the potential for producing a prototype for field testing. One or more prototypes of a percent solids monitor are needed for comparative testing at Oak Ridge National Laboratory in FY98 and for ultimate deployment in support of tank slurry retrieval and transfer operations at Oak Ridge and Hanford. After reviewing Sheen's project progress, capabilities, and plans, Bastiaans and Thomas recommended that FY98 funding be provided to allow Sheen to continue prototype development for percent solids monitoring. Sheen will be required to provide a prototype for testing by May. Bastiaans provided a report on the visit and a written recommendation to the leadership of the CMST-CP.

Support for CMST-CP program management:

- Bastiaans attended a meeting of decontamination and decommissioning (D&D) technology developers and users entitled X-Change '97 on December 1 through 5. The meeting was sponsored by the D&D Focus Area in collaboration with other DOE and industry organizations with interests in the area. The purpose of the meeting was to encourage deployment of new D&D technologies through better communication between users and developers. A report on the meeting was prepared and distributed to the CMST technical support team.
- As part of the travel mentioned immediately above, Bastiaans also visited the Hemispheric Center for Environmental Technology at Florida International University (HCET/FIU) on December 8 to discuss CMST-related projects being pursued there as part of a five-year, EM-50 supported project sponsored by University Programs. For FY98, FIU has six active CMST-related projects in programmatic and technology development areas. A report on the HCET/FIU activities and possible future interactions with HCET/FIU was submitted to the leadership of the CMST-CP.
- Haas and Bastiaans participated in CMST-CP team conference calls on December 10 and 23. Topics addressed included: team member activities, consideration of Site Technology Coordination Group needs statements, preparation of the CMST-CP Multi-Year Program Plan, tank slurry monitor testing and development tasks, the annual projects review meeting, gate reviews, Innovative

Technology Summary Reports, additional cost savings analysis work, and involvement of DOE personnel from the Environmental Measurements Laboratory in the program management and technical support activities of the CMST-CP.

- Bastiaans and Haas prepared the High Level Waste (Tanks) and Mixed Waste portions of the draft CMST-CP Multi-Year Program Plan (MYPP), respectively, and forwarded the same to Paul Wang. Haas sought input from Bill Owca, Mike Connolly, Whitney St. Michel, and Steve Priebe, of the MWFA, and Paul Hurley, representing CMST-CP nondestructive assay and evaluation (NDA/NDE) technology development. Haas also sought feedback from the MWFA personnel after the draft input was prepared. Bastiaans and Haas also worked with Dave Roelant and Wang, providing input for establishing program priorities and providing constructive written input on the entire draft MYPP. This task was completed December 18.
- In response to Dave Hippensteel's inquiry, Haas and Bastiaans provided written information regarding CMST-CP and Ames Laboratory work with the Consortium for Site Characterization Technology on December 23.
- Bastiaans and Haas began collection and preparation of information for updating Technology Summary Sheets (TSS) for projects within their purview. One anticipated use for the TSS is as part of the material for the OST semi-annual reports to Congress.
- Bastiaans and Haas began preparation of facilitator presentations for the FY98 CMST-CP kickoff meeting.
- As requested by Roelant, Bastiaans and Haas provided constructive written input and comments for the draft FY98 Performance Plan for the CMST-CP on December 30.

Support to DOE Office of Energy Efficiency and Renewable Energy (EE). At the request of Eric Lightner of the DOE EE Office of Industrial Technology, Haas provided information concerning an Electric Power Research Institute (EPRI)-proposed collaboration with the DoD and DOE on the subject of CEM development. Haas provided a copy of the May 1997 letter from Caroline Purdy, CMST-CP, to George Offen, EPRI, regarding a similar, previously proposed collaboration. Haas also provided Lightner with the Internet address for the "CEM Technology Development Strategy Document" prepared by MWFA and CMST-CP personnel.

PI: Bill Haas, Ames Laboratory, (515) 294-4986