OFFICE OF SCIENCE & TECHNOLOGY

Characterization,
Monitoring,
& Sensor
Technologies

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Progress Reports

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& Sensor Technology
Crosscutting Program

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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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FETC Index

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.)

Project Number	Project Name	Page	Subsurface Contaminants	Tanks	Mixed Wastes	D & D	Coordination
AC21-92MC29101	High-Resolution Subsurface Imaging and Neural Network Recognition		**P**				
AC21-92MC29103	Development of a Long-Term, Post-Closure Radiation Monitor		**P**	✓			
AR21-94MC31178	A Steerable/Distance Enhanced Penetrometer Delivery System		**P**				
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AR21-95MC32110	Measurement of Radionuclides Using Ion Chromatography and Flow-Cell Scintillation Counting	6	**P**			✓	
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AC21-96MC33124	*In Situ* Permeability Measurements with Direct Push Techniques	3	**P**				
AC21-96MC33125	Subsurface Barrier Validation with the SEAtrace™ Monitoring System	11	**P**	✓			
AC21-96MC33128	*In Situ* Tritium Beta Detector		**P**				
AC21-92MC29108	Field Raman Spectrograph for Environmental Analysis	19	✓	**P**	✓	✓	
AR21-93MC30363	Robotic End Effector for Inspection of Storage Tanks	15		**P**			
AC21-96MC33126	Automated Monitoring System for Fluid Level and Density in High-Level Waste Tanks	16		**P**			
AC21-92MC29115	Intelligent Inspection and Survey Robot				**P**	✓	
AC21-93MC30173	Waste Inspection Tomography	22	✓		**P**	✓	
AC21-96MC32194	A Continuous Emission Monitor for Toxic Metals in the Offgases of Thermal Treatment Facilities				**P**		
AC21-96MC33127	Nondestructive Examination and Assay of Drums Containing Transuranic Waste	24			**P**	✓	
AC21-93MC30172	Characterization for Radioactive Contamination Inside Pipes with the Pipe Explorer™ System		✓			**P**	

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Project Number	Project Name	Page	Subsurface Contaminants	Tanks	Mixed Wastes	D & D	Coordination
AC21-93MC30175	Portable Sensor for Hazardous Waste		✓		✓	**P**	
AC21-93MC30176	3-Dimensional Integrated Characterization and Archiving System (3D-ICAS)		✓		✓	**P**	
AC21-94MC31190	Coherent Laser Vision System				✓	**P**	
AR21-95MC32093	Diagnostics and Data Fusion of Robotic Sensors					**P**	
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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.

- **Site Characterization and Analysis Penetrometer System Logistics**
  A field trial of an EIC-developed Raman probe was conducted in the Savannah River Site A/M area during the week of February 2. Dense, nonaqueous, phase liquid contamination was detected using cone penetrometer-based Raman spectroscopy. A team of researchers from EIC, Fugro Geosciences, and the Savannah River Technology Center identified tetrachloroethylene (PCE) in clay-rich sediments in the vadose zone during three pushes in two areas. The EIC tool uses fiber optics to carry laser excitations to the sediment through the cone tip and back to the surface-based spectrometer detection system. (Page 1)

- **Tomographic Site Characterization Using Cone Penetrometer, Electrical Resistivity Tomography, and Ground Penetrating Radar**
  A field demonstration at the Savannah River Site resulted in the successful integration of the cone penetrometer (CPT) with electrical resistivity tomography (ERT) for tomographic imaging of the subsurface. CPT resistivity profiles were obtained during installation of the electrodes and used to conduct numerical studies and in the inversion of the ERT data. Studies reveal the importance of the CPT resistivity profile in improving the numerical tomographic imaging process to converge on an accurate optimal solution. Planning of another field demo will involve numerical simulation to help determine appropriate electrode spacing and appropriate scheduling of the ERT data acquisition equipment, which will help obtain the highest quality data possible. (Page 5)

- **Development of an On-Line, Real-Time, Alpha-Radiation Measuring Instrument for Liquid Streams**
  Initial testing of the assembled Thermo Alpha Monitor was successfully conducted this month. The draft field test plan was completed, outlining the protocols to be followed during the upcoming field test of the instrument in March at areas outside Oak Ridge National Laboratory (ORNL) in coordination with another ORNL pump and treat project. (Page 7)

- **SEA Barrier Validation Technology Offered as a Commercial Service.**
  Science and Engineering Associates (SEA) staffed an exhibition booth at the symposium "Subsurface Barrier Technologies - Engineering Advancements and Application Considerations for Innovative Barrier Technologies" to publicize the availability of the barrier validation system. The conference, held January 26 and 27 in Tucson, Arizona, had 90 participants and focused on advancements in the barrier business from both the industrial and governmental sector. (Page 11)

Subsurface Contaminants

Plumes

Expedited Site Characterization

Site Characterization and Analysis Penetrometer System Logistics (Westinghouse Savannah River Company)

Objective

The cone penetrometer is becoming the tool of choice for environmental site characterization in unconsolidated and semiconsolidated formations because it allows access to the subsurface in a rapid and cost-effective manner. Many sensors and probes for use with the cone penetrometer are being developed and demonstrated for environmental characterization by the OST.

This project is being funded to provide logistical support for field demonstrations and funding for the operation and maintenance of the Site Characterization and Analysis Penetrometer System (SCAPS) cone penetrometer by a commercial cone penetrometer company at SRS.

Progress

A field trial was conducted in the SRS A/M area during the week of February 2 to determine whether Raman spectroscopic techniques are appropriate for direct detection of dense, nonaqueous phase liquid (DNAPL) in the A/M area before scheduling a full-scale field evaluation. Raman spectroscopy is an inelastic, light-scattering technique that can identify contaminants by their unique spectra.

An EIC-developed probe was delivered to SRS for the preliminary testing. The field trial was successful; DNAPL contamination was detected using cone penetrometer-based Raman spectroscopy. A team of researchers from EIC, Fugro Geosciences, and the Savannah River Technology Center identified tetrachloroethylene (PCE) in clay-rich sediments in the vadose zone during three pushes in two areas. High concentrations of PCE in these zones were previously identified by conventional coring and laboratory analyses. The EIC tool uses fiber optics to carry laser excitations to the sediment through the cone tip and back to the surface-based spectrometer detection system.

Representatives from Lawrence Livermore National Laboratory and Special Technologies Laboratory were also scheduled to bring their probes to SRS for the preliminary testing. However, their field team was unable to travel because of severe weather conditions in California. They will participate along with EIC in the field evaluation tentatively scheduled for late May or early June.

PI: Carol Eddy-Dilek, Westinghouse Savannah River Company, (803) 725-2418

Internal Reflection Sensor for the Cone Penetrometer

Objective

This project will design, assemble, and test a prototype Internal Reflection Sensor (IRS). The sensor will be deployed in a cone penetrometer during site characterization with the goal of providing real-time, *in situ* detection of nonaqueous phase liquids (NAPLs) without interference from dissolved contaminants, water, soil, or other natural subsurface constituents.

Progress

A preliminary field test is scheduled for February 2 to 6 at Savannah River Site (SRS). The primary objective of this "shakedown" test is to ensure that the sensor will operate in conjunction with the cone penetrometer system. EIC provided SRS personnel with the requirements to interface their sensor to the cone penetrometer, and they modified the cone system to receive the sensor. The sensor was tested and shipped to SRS.

PI: John Haas III, EIC Laboratories, Inc., (617) 769-9450

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

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

The PI continued to work on input to final report, and the evaluation of the Luckey Effort was completed.

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 prototype probe is being fabricated. While most of the machining is completed, the filter material used to prevent soil particles from entering the sensor chamber is requiring more time to specify and incorporate in the assembly. We do not expect to receive the prototype rod section until February 20. Planning and discussions are continuing with Savannah River Site staff for the demonstration tests. The current schedule is to conduct the demonstrations in April. If no significant problems are encountered in the fabrication of the prototype, we should have no difficulty meeting the demonstration schedule. After we receive the prototype, we will conduct our calibration and laboratory tests, then ship the unit to Applied Research Associates for a test push in their soil.

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

One of the objectives of this project is to improve the filter material on both the dynamic thermal desorption (DTD) and the cone in situ purge (CISP) probes. With the previous designs, problems with screen clogging were experienced when pushing through clayey soil. We have selected materials that should allow us to overcome this problem. The design is similar to the wellscreen material used in the oil industry called Pall Stratapac Screen developed by Pall Well Technology, Glen Cove, New York. It will consist of an outer cage of perforated tubing with a series of fine-mesh screens wrapped inside, followed by the original sintered filter on the mandrel. The difference is that the new design will not incorporate concentric fine-mesh screens embedded with sintered material. We are awaiting delivery of the material to begin manufacturing the new screen design for the two probes. These materials will be tested to confirm that new approach offers better resistance to clogging than the original approach.

The results of the transfer efficiency comparison study indicated that Teflon FEP is the better material to use as a transfer line. We are assembling the umbilical to include the Teflon FEP transfer line and a higher power (12-watts/ft vs.10-watts/ft used previously) heat trace. The umbilical will consist of a single bundle, which incorporates all of the wires for the electronics as well as the transfer lines and heating element power supply lines. This will ease the handling characteristics of the umbilical and improve its durability. We selected the filter materials for the DTD and CISP probes and are awaiting delivery of the material. We arranged to receive the surface acoustic wave/gas chromatograph (SAW/GC) from Electronic Sensors Technology (EST, formerly Amerasia).

We decided not to participate in the Superfund Innovative Technology Evaluation (SITE) program because the estimated demonstration date is late summer/early fall, which is after the completion date of this contract. We are actively pursuing conducting the demonstration at the Groundwater Remediation Field Laboratory at Dover Air Force Base. This is a Strategy Environmental Research and Development Plan (SERDP) funded site. We are looking for a well characterized area of the site that has both chlorinated solvents and BTEX contamination. Once an area is located, the budget will be re-analyzed to assess change in program. Actual fielding costs are expected to decrease slightly; however, the analytical costs (i.e., confirmation sampling) may increase over the scenario where we participated in the SITE program. As part of the SITE program, the EPA covered all analytical testing. This issue is being analyzed further and discussed by the PI and the COR to confirm the decision of changing the demonstration site.

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

A field demonstration at the Savannah River Site (SRS) resulted in the successful integration of the CPT with ERT for tomographic imaging of the subsurface. ERT and CPT were used to detect the change in soil electrical resistivity within the cone of depression in an aquifer near an active pumping well. CPT resistivity profiles were obtained during installation of the electrodes at the site and used to conduct numerical studies and in the inversion of the ERT data. Studies conducted before and after the ERT field demonstration reveal the importance of the CPT resistivity profile in the tomographic imaging process. The CPT resistivity profile, when used as an initial starting point, greatly improves the numerical tomographic inversion model's ability to converge on an accurate optimal solution.

Because ERT involves complicated nonlinear numerical inversion methods from extensive data taken in the field, pre and post processors were written to increase the ease of performing and analyzing ERT tests. Pre processors include easily making data acquisition schedules in a format accepted by the data acquisition equipment as manufactured by Zonge Engineering Inc. Post processors include easily taking data from Zonge equipment format, analyzing the data for noise and validity, transferring the useful data into an input deck for the numerical inversion code, and easily processing the output from the inversion code into a tomographic image of the subsurface.

Planning began for a second field experiment. This second demonstration involves using ERT and CPT at a contaminated site at SRS. Planning of this field demo will involve numerically simulating what is expected at the contaminated site based on previously gained soil resistivity data. Numerical simulation will help to determine appropriate electrode spacing and appropriate scheduling of the ERT data acquisition equipment, and will also aid in designing an ERT test that will obtain the highest quality data possible.

James Shinn will assume responsibilities as PI on this project. All tasks were completed with the exception of a second field demonstration that is being considered for additional contract funding. The second demonstration is to advance the ERT/CPT technology for monitoring a contaminated area. This second field demonstration and completion of the final report will begin when further contract funding and contract tasks are supplied.

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

Flow-cell scintillation detector development. Testing with Monoflow 5 yielded minimum detectable activities of 0.3 Bq/ml for alpha particles and 0.6 Bq/ml for beta particles. The dual parameter analog data acquisition system was connected to the homogeneous flow-cell detection system, and spectra were obtained.

Development of the digital pulse shape discrimination data acquisition system continues. A program to analyze the photomultiplier tube anode pulses continues. This program will integrate individual pulses from the photomultiplier and use this information to characterize pulse shape.

Cs:TI particles coated with Parylene C from Specialty Coating Systems were received. The scintillator will be evaluated within the next few weeks.

Development of sample processing protocols. Unprocessed aliquots from the Savannah River Technical Center (SRTC) high activity drain tank sample were analyzed using the chromatography system to provide a baseline for the effectiveness of the sample preparation protocol. Four 1-ml aliquots of the SRTC sample were processed using microwave-aided acid digestion to oxidize the organic material and oil present in the sample before employing the extraction chromatography.

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

Initial testing of the assembled Thermo Alpha Monitor was successfully conducted this month. The draft field test plan was submitted, outlining the protocols to be followed during the upcoming field test of the instrument. Comments were received from the COR and incorporated into the plan. Preparation of a commercial prototype, analysis, design, and costing report continues; the report summarizes the design and corresponding manufacturing cost estimate for the planned commercial instrument.

A field demonstration at areas outside Oak Ridge National Laboratory (ORNL) will begin in March in coordination with another ORNL pump and treat project.

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 gave a presentation on the EMWD technology to the Hanford Environmental Restoration group. We also toured the site, particularly the tank farms, to assess the site condition that would be encountered in an EMWD demonstration. Drilling is difficult in the areas of the tank farms because of the cobble zone; it is difficult to navigate through the cobble and to keep a borehole open. The EMWD tool is designed to be used behind the drill bit while drilling. If the drill can be navigated through the cobble, it is likely the EMWD tool will function to provide position and contaminant concentration data. Follow-up discussions are occurring. We continue to pursue contacts with the U.S. Navy at Port Hueneme, California; Savannah River Site; and Oak Ridge National Laboratory.

With the Sandia National Laboratory (SNL) Technology Transfer staff, we completed a nondisclosure agreement with Charles Machine Works (CMW) and began discussions about a possible license for the SNL coaxial cable coil in early March. We are also discussing a possible licensing arrangement with Applied Physics System to manufacture the sensor and telemetry portion of the EMWD tool

We submitted a paper entitled “Integration and Evaluation of a Position Sensor with Continuous Read-out for Use with the Environmental Measurement-While-Drilling-Gamma Ray Spectrometer System” to NO-DIG '98.

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

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

Analysis of the cross-borehole air-injection interference packer tests conducted in fall 1995 continues. Preliminary analysis indicates that the magnitude of the pressure buildup in the injection interval and the pressure responses measured in monitoring intervals are strongly affected not only by separation distance but also by vertical and horizontal position. The presence of a fracture zone or other high-permeability feature intersecting one well of a pair of wells can serve to break the pneumatic connection between two wells, as air will flow preferentially along the higher-permeability path. Plots of depth versus pressure buildup in a packed-off interval in a well can serve to identify the depths of zones of relative high and low permeability. In addition, permeabilities of different depth zones were estimated using steady-state models for one-, two-, and three-dimensional flow geometries.

Analysis of the 1997 field infiltration test continues.

Preparation and review of journal articles summarizing the results of the project continue.

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

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

Charles R. Cole participated in the January workshop in Moscow with Environmental Measurements Laboratory, PSA Hydrospetzgeologiya, PA Mayak, and British Nuclear Fuels, Ltd.

We completed the final draft of the manuscript "Modeling Intercomparison Study to Investigate a Dense Contaminant Plume in the Complex Hydrogeologic System Around Lake Karachai, Urals, Part 1 – Hydrogeologic Features and Problem Formulation," by Zinina, Zinin, Williams, Cole, Foley, Vasil'kova, and Samsonova. Following final approval by our Russian colleagues, we will submit it to the journal. Work continued on graphics and final text for Part 2 – Results.

We completed text, page, and cover design for the injection book and continued to prepare the camera-ready copy for Battelle Press.

We began digitizing the Mayak site characterization data received in January 1997 and reconciling them with previously received data. We tested our software for the conversion of all of our Mayak GIS coverages to be used in modeling to the Russians' Mayak plane coordinate system and then initiated conversion.

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 continued on completing the final draft of the electrical impedance tomography (EIT) paper; comments were solicited from more reviewers.

The problems using the 3D code on the Dover phase 2 data were solved, and we have a preliminary result for half of the target volume (the mesh is so large that it has to be broken into two parts, with each part run separately). The next step is to run the full mesh.

Major accomplishment. Preliminary laboratory data indicate that EIT may be sensitive to chemical reactions. If this work is confirmed, it may be possible to image subsurface chemistry.

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

Subsurface Barrier Validation with the SEAtrace™ Monitoring System

Objective

This effort will develop and demonstrate an integrated methodology and field system to evaluate the integrity of *in situ*, impermeable barriers constructed in the vadose zone. The methodology relies on the predictable process of binary diffusion of a tracer in the soil gas. A known concentration of tracer gas would be placed on one side of the barrier wall and soil gas samples would be drawn from known locations on the other side. Using inverse modeling methodology, the history of soil gas concentration at the various sampling locations allows determination of the leak location and its size.

Progress

Phase 1 topical report review comments were received. Science and Engineering Associates (SEA) responded to the comments and transmitted the responses to FETC on January 30.

SEA purchased booth space for the symposium "Subsurface Barrier Technologies - Engineering Advancements and Application Considerations for Innovative Barrier Technologies." This conference, held in Tucson on January 26 and 27, had 90 participants and focused on advancements in the barrier business from both the industrial and governmental sector.

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

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

Post-Closure Monitoring

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

The assessment of Hanford site technology needs and survey of Internet sites continue. Additional personnel at the Hanford site and in administrative positions for Hanford projects were contacted; discussions regarding needs continue.

Discussions continue with CMST-CP management personnel regarding the necessary output of this project for management implementation. Discussions with Savannah River technical personnel regarding the needs of that site began.

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 draft document for review by technology users, purchasers, and project sponsors. The document will be published in print form and on the Internet with search and interactive capabilities. Additional technologies used in other federal programs (i.e., DoD, DoC, DoI) as well as at private company sites will be included in the out-years.

Progress

The survey form developed in FY97 was modified. A presentation to introduce survey respondents to the purpose of the survey was drafted.

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 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

This month's emphasis has been the examination of the EPA Environmental Technology Verification Program (ETV). Our activities were geared toward becoming familiar with the program's structure, with a view toward defining those areas where a validation program would be most appropriate. The ETV program consists of six pilot programs designed to promote partnerships with stakeholders, private industry, academia, and regulators. Currently, the pilot programs are comprised of:

- Drinking Water Systems
- Pollution Prevention and Waste Treatment Systems

- Site Characterization and Monitoring Technologies
- Indoor Air Products
- Pollution Prevention through Improved Coatings
- Independent Entity option (a totally independent, private approach to verification)

It appears that those programs holding promise for possible opportunities for HCET are Drinking Water Systems and Site Characterization and Monitoring Technologies. Part of the Drinking Water program is intended to develop standard verification protocols and carry out independent testing. Although some analytical services will be contracted with certified laboratories, opportunities may exist for HCET to act as an objective third party entity, a strategy proposed for developing HCET opportunities. Also, HCET could play a role in method development where initial certification may not be an immediate requirement. Technical areas of interest within the program include investigation of microbials, particulates, and disinfection by-products. The capabilities of the laboratory are consistent with the latter two.

The Site Characterization and Monitoring Technology pilot program has demonstrated nine innovative technologies within three major technology classes. These include cone penetrometers, field-portable gas chromatography/mass spectrometry (GC/MS) for volatile organics in water and soil, and emerging technologies for detection of toxic metals in soil. The capabilities of the HCET Analytical Laboratory, with its GC/MS, HPLC, X-ray dispersive analysis, and atomic absorption equipment, are particularly related to these interests. Reports and verification statements for seven of these technologies were already issued, and additional reports for *in situ*, real-time devices for sampling soil, soil gas, and groundwater are planned to be verified. Again, the philosophy of HCET acting as an objective third party entity may be pertinent here.

The Pollution Prevention and Waste Treatment Systems pilot program involves partnerships with the state of California. Solicitations for these technologies were made in 1996, and 10 were selected. They may now be ready for verification activities.

The Improved Coating program may provide opportunities for HCET, given their materials evaluation capabilities. Tests were scheduled to be conducted in March 1997, and questions of verification may be timely now.

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 remaining components for the electronic system were received. These components include the new camera controller, short circuit protection, and updates for the standoff sensors. The standoff sensors were installed, and the internal wiring harnesses were modified to interface with the new electronics package from Technical Software Consultants. All of the standoff sensors were tested before and after integration into the RTIEE. Software integration of the standoff sensor software library is in progress.

Half of the EDM notched plates were received, giving us an inventory of nine plates to scan. In February, all of the plates will be scanned repeatedly to give a statistical quantization of RTIEE's detection and characterization effectiveness.

OSS completed prototyping the Tank 16 annulus sampling tool scarifying vacuum recovery system. The system was demonstrated to representatives of Westinghouse Savannah River Co. during a plant tour on January 19. The test was satisfactory, and OSS was authorized to complete manufacturing of a tank-ready system to be delivered in mid February.

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

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

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

A conference call was held with personnel from Science and Engineering Associates (SEA), the Tanks Focus Area (TFA), the Savannah River Site (SRS) Defense Waste Processing Facility (DWPF), the CMST-CP, and FETC to discuss the phase 2 work scope of this project. After discussion, the following group consensus recommendations were made:

1. SEA efforts to construct and demonstrate a full-scale capacitance sensor array for application to aqueous/organic liquid interface measurements in DWPF process vessels should be put on hold for at least one year pending a final Westinghouse Savannah River Corp. (WSRC)/DOE decision on the In-Tank Precipitation (ITP) process. This decision was based on the recent public announcement that WSRC has suspended work on the ITP process at SRS while other process options are being considered. The identified SRS application of the aqueous/organic liquid interface sensor is in the organic evaporator vessel and associated condensate vessel, which are part of the DWPF Salt Processing Cell. The purpose of the Salt Processing Cell is to treat feed from the ITP process (to remove organics) before it is transferred to the Chemical Process Cell (which prepares feed for the melter). Therefore, the justification for developing the aqueous/organic liquid interface measurement depends on the need for the ITP process now being reviewed by WSRC and DOE.

2. SEA efforts to explore the feasibility of acoustic sensor arrays for application to glass frit/aqueous interface measurement in a DWPF holding vessel for recycle of contaminated glass frit should also be put on hold for at least one year pending SRS assessment of other options for decontaminating HLW canisters. Although this effort was not stated in the phase 2 statement of work for SEA, some R&D during FY98 on this concept has been under consideration, depending on the availability of time and resources. This need has been discussed among SRS, SEA, and the TFA in prior meetings. However during the conference call, George Weeks indicated that he had an assignment to examine other options such as CO_2 pellet blasting as a

means for decontamination and would report his recommendations by the end of FY98. Therefore, justification for developing this type of interface sensor also depends on the outcome of a SRS review.

3. All SEA efforts in the phase 2 contract should be redirected to a SRS need to monitor the vertical profile of wt% suspended solids in the settle-decant process of extended sludge processing (ESP). This option was recommended because SRS has indicated this need through prior TFA/SRS meetings and submitted the need in the current Site Technology Need/TFA Response process. The technology need is to: (a) measure the vertical profile of wt% suspended solids in an ESP tank,
(b) monitor the rate of suspended solids settling to determine when steady state is being approached, and (c) determine the depth of supernatant in which suspended solids are less than 0.1 wt%. New phase 2 milestones for the project were discussed, and a strawman for the revised statement of work was generated.

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

We continued laboratory tests at the Argonne National Laboratory solid/liquid slurry facility to determine the optimal sensing geometry for the ultrasonic instrument to measure percent solid concentration. Temperature and flow rate effects are being examined.

The draft of the FY97 annual report is being edited. The technical task plan was updated.

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

The test plan was completed and approved by the CMST-CP project facilitator by the scheduled date. The completion of this task met a headquarters milestone.

The incorporation of comments and revisions into the draft report for the surrogate testing of the slurry monitoring instruments was temporarily halted so the test plan could be completed.

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

Waste Sampling/Analysis

Integrated Raman pOH Sensor for In-Tank Monitoring

Objective

This project will design, assemble, and deploy an *in situ* monitor for corrosive species in DOE's large-scale waste tanks. The base phase of the program includes a series of tests designed to establish the feasibility of a fiber-optic Raman sensor to detect anions of interest at concentrations typically found in the tanks. Materials proposed for use in the tanks will be evaluated under conditions of elevated pH, temperature, and radiation. Lastly, the requirements and preliminary design for a liquid sampling system compatible with both the Raman probe and existing tank deployment hardware will be developed in the base program. Follow-on work will include assembly of a fully functional instrument and deployment in real waste tanks.

Progress

The determination of analytical figures of merit for individual anions of relevance to in-tank corrosion was completed this month. We also began evaluating mixtures of these anions to determine possible interference between anions. We expect to complete the mixture analysis next month.

In-tank material evaluation experiments were initiated. A long-term study of the effect of alkali on polymers and metals considered for the tanks began. We are also gathering materials and designing the radiation testing experiments.

Milestone status. Task 1, Raman feasibility tests, is 75 percent completed. It is scheduled for completion on March 31.

PI: John Haas, EIC Laboratories, (617) 769-9450

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.

Progress

The cone penetrometer evaluation is scheduled for February 2 to 6 at the Savannah River Site (SRS). This month, EIC prepared for the trip and shipped their equipment to SRS. Discussions were held with SRS personnel and their subcontractors regarding interfacing requirements between the Raman system and the cone penetrometer. For the evaluation, SRS will provide a cone that can accommodate the EIC Raman probe. We also began preparation of the instrument manual and continued work on the final report.

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

All of the data acquisition/reduction hardware was received. The computer cards were installed on a machine and verified to operate properly. A compatibility problem between these cards and the in-house software developed last month was identified. Simplistically stated, the cards and the in-house software both use the same commercial driver device, and the computer gets confused as to which one it is supposed to talk to. This problem is not expected to be insurmountable. The commercial data acquisition/reduction software was ordered.

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 continued to perform a series of experiments on the in-plant 2.05 Tesla permanent magnet system. These studies were designed to provide maximal practicality and flexibility in setup and operating conditions. Therefore, all experiments were

performed to provide high sensitivity and verify the range of operating conditions. As in previous studies reported on this magnet system, all experiments were performed on specimens in 5-mm diameter nuclear magnetic resonance (NMR) tubes with an active volume of 0.2 ml. The experiments demonstrated a signal-to-noise ratio of 1 at 25 micromolar concentration of pertechnetate using a 12-minute analysis time. The Class A waste disposal limit is 0.3 Ci/m^3 (for ^{99}Tc, this equates to 178 micromolar), and the spectrometer's sensitivity threshold is currently a factor of 7 below this limit. Further increases in sensitivity are expected as system modifications to the radio frequency probe and circuitry are implemented.

We nearly completed the safety reviews and requirements needed to perform a series of ^{99}Tc oxidation/reduction experiments in the NMR facility. These experiments will be performed on both Tc standards and actual waste materials obtained from Pacific Northwest National Laboratory. Experiments are expected to be performed next month.

In other matters, as this technology is maturing, it is imperative that we establish a significant interaction with the user community. Therefore, we are increasing the visibility of this program through both direct interactions with the nuclear community and through publications and open technical presentations at meetings of international scope. We were recently contacted by Karl Bishop from Fernald. Karl, while interested in this Tc monitoring technique, is required to monitor materials in solid state. Additionally, we were contacted by J. Vincent Panesko from the Pacific Rim Enterprise Center. Vincent is supported by EM to facilitate EM's technology marketing to the user community. We are supplying Vincent with an informational package, and Vincent will contact appropriate players in British Nuclear Fuels, Ltd., and Lockheed. In addition to these contacts, we are presenting this technology at Pittcon '98 in New Orleans, March 1 to 5, and at the American Chemical Society Annual Meeting, Nuclear Chemistry and Technology Division, in Dallas from
March 29 to April 3. This technology was previously presented at the American Chemical Society in Las Vegas, Division of Nuclear Chemistry and Technology, where the comments and interactions with other researchers proved quite valuable.

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

Bio-Imaging Research (BIR) received a signed contract modification endorsed by both BIR and FETC this month. The project is now in phase 3, which is designed to achieve commercial viability by providing WIT with increased nondestructive assay throughput resulting in less than 1 hour per drum for Active and Passive Computed Tomography (A&PCT) assay.

Activities in January included:

- Placing a BIR purchase order to EG&G ORTEC at Oak Ridge for the 6-channel HPGe Array that has an 18-week lead time.
- Executing the Work-for-Others Subcontract between BIR and Lawrence Livermore National Laboratory (LLNL) for the new multi-detector software upgrade for A&PCT.
- Executing the consulting agreement between BIR and BIR's nuclear physics consultant, Dr. Dave Camp.
- Placing BIR Purchase orders for the new WIT bar-code reader and the WIT CPU upgrades required for new software (i.e., 66 Mhz Pentiums are being replaced by 233 Mhz systems). Windows 3.11 is being replaced with Windows 95, and the older version of the WIT trailers's BIR ACTIS operating system software from 1993 that ran on Interactive UNIX then is now being upgraded to the latest 1998 Revision that runs on SCO UNIX PC platform and requires the newer PC motherboards. Also, WIT's old 8 gigabyte, 4 disk RAID (that cost $9 K in 1993) is being replaced with a more reliable 9 gigabyte single HD (that cost $700 today).

- Placing a purchase order for 2 <10 μCi check sources (^{133}Ba and ^{152}Eu) that are non-licensable per NRC requirements and that will be used for WIT A&PCT calibration to check out all A&PCT system functions onboard WIT.
- Beginning multiple detector mechanical designing.

Dave Camp and a technical representative from EG&G ORTEC are scheduled to be at BIR the second week of February to prepare a spectroscopy presentation of available EG&G and LLNL software codes as well as a course on WIT spectroscopy for WIT operating personnel.

Plans were made for LLNL's Pat Roberson to visit BIR the third week in February to review and test the new WIT A&PCT calibration procedure, to discuss the new multi-detector software development activities, and to schedule a preliminary software design review.

The BIR web site (www.bio-imaging.com) is now functional, and the WIT program is featured. Links to CMST, LLNL and the Carlsbad Area Office (CAO)/Waste Isolation Pilot Plant are included. We will add links to FETC and others in the future.

This month BIR hired Dr. David Nisius, Ph.D. who has worked at Argonne National Laboratory-East since 1993 as a post-doc from Purdue University. His project consisted of work on the 110-channel HPGe detector gamma sphere including detector design. He officially starts at BIR on April 1, but will take 24-hour SARA OSHA training in early March. He already has a DOE RAD-1 worker card from Argonne. He will be a valuable BIR asset in the design and production of the multi-detector WIT HPGe system, and he brings valuable, extensive, and relevant gamma spectroscopy experience. In addition, he will support BIR development efforts in new and innovative X-ray detector developments and image processing that are non-WIT related activities.

BIR also hired another WIT operator as a full-time BIR employee. Mr. Howard (Dan) MacInerney is installing the PC upgrades to WIT as described above and will be responsible for installing the new multi-detector system. As a new WIT trainee, he will also support the WIT-CAO TRU certification program at the Nevada Test Site.

As an aside, BIR will be investigating the feasibility of using WIT's 2MeV CT scanning with 3D volume rendering capabilities on T-REX dinosaur vertebra and jaw bone sandstone fossils from Chicago's Field Museum of Natural History. These fossils are from the nationally renowned T-REX set of bones that has been in the national news recently. Chicago's Field Museum recently purchased the entire T-REX fossilized skeleton for more than $8M. We will determine if the bone density is different enough from the sandstone matrix to CT image the bone and separate it from its matrix. If this looks feasible, we may get an entire WIT CT volume rendering of the bones.

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

In January, Lawrence Livermore National Laboratory (LLNL) performed further image processing on the eight Rapid Commercialization Initiative (RCI) drums that were assayed by the WIT system between October 1996 and January 1997. LLNL completed the development of volume images for each of the drums that represent the following:

- a volume image with voxels that represents the drum mass based on percent of the mass attenuation coefficient,
- a volume image with voxels that represent the total drum Pu mass,
- a volume image with voxels that represent the total drum ^{239}Pu mass,
- a volume image with voxels that represent the total drum ^{241}Am mass, and
- a volume image with voxels that represent the total drum ^{235}U mass.

LLNL will complete a final report of work in February and will send the data and report to Bio-Imaging Research (BIR).

BIR completed the needed software modeling to merge the expected LLNL Active and Passive Computed Tomography (A&PCT) data described above with similar APNEA data from TRUtech. BIR still does not have confirmation from TRUtech that the APNEA data will be available in February. BIR will pursue a TRUtech confirmation.

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

One-half of the second test cycle was completed this month. The Canberra high efficiency neutron counter (HENC) completed all 32 test samples and was moved out of the facility on January 22. Approximately two-thirds of the analysis reports were received.

Activities continued to resolve issues associated with the lost/damaged Europium source associated with the IQ-3 gamma assay system. The damaged source was packaged and shipped to Isotopic Products for repair. Investigations were still ongoing concerning how the transportation package was damaged.

It is anticipated that IQ-3 will receive the repaired source, complete calibrations, and begin the performance demonstration by the first week in February.

Cycle 3 participant arrangements continued. A commitment for the Los Alamos Tomographic Gamma Scanner (TGS) to arrive at the test facility on February 23 was established. After the departure of the HENC system, preparations for the TGS system began.

The initial allocation of funding for this performance demonstration was exhausted. Efforts are in progress to arrange for additional funding to allow cycle 3 to be performed.

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

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

Our new end-user group at Savannah River, the Am-Cm Stabilization Project, has provided sufficient information for us to build the monitor. A Request for Quotes was issued for purchasing the acousto-optic tunable filter crystal around which the monitor will be built. The data processing and control devices were already purchased. Optical design of the monitor began.

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 the design of the next generation HiRIS. Some components were ordered, and we are evaluating other options. We completed incorporation of a multielement detector into our control software system. Some components arrived for the next generation device; more are anticipated during February.

We are discussing problems with the acousto-optic tunable filter device purchased last fiscal year with the manufacturer. The device will be sent to the manufacturer for evaluation.

A paper entitled "A High Resolution Interferometric Spectrometer for Continuous Emission Monitoring" was accepted for presentation at the American Chemical Society National Meeting in Dallas at the end of March.

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-induced breakdown spectroscopy (LIBS) 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 final technical developer report was completed for the September 1997 EPA Incinerator field test. This report was forwarded to the continuous emissions monitor test committee for inclusion in their formal test report.

The alternative lead atomic emission line investigated during December 1997 was found to yield substantial improvements in the lower detection limits of lead during the January field test at the Naval Air Weapons Station in China Lake, California. The new line is the Pb I line at 405.78 nm, which yielded a detection limit of approximately

20 micrograms/actual cubic meter. All data were recorded and processed in true real-time, with LIBS-based on-line gas analysis performed continuously with a nearly 100 percent sampling rate.

A more thorough analysis of the November field trials data (Bakersfield, California) was completed. The LIBS-based monitor was successful in detecting sodium, magnesium, calcium, and silicon in ambient air at low part-per-billion to part-per-trillion concentration levels. The signal-to-noise levels were excellent at the low levels and were obtained using the conditional analysis method. Size distributions were recorded for modal values near 200 nm and near 1 micron in diameter. This work is consistent with the task of exploring the feasibility of using LIBS for particle sizing and composition in addition to total concentration measurements.

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

Disposition of Facilities (D&D)

Metals and Pipes

Portable X-Ray, K-Edge Heavy Metal Detector

Objective

The purpose of this work is to support D&D activities through development of improved nondestructive assay techniques for detecting and quantifying uranium, plutonium, and other heavy metals. The work is focusing 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 the sensitivity for detecting heavy metals, while minimizing the measurement time. The basic demonstration of the technique was completed; a sensitivity for detecting a 2-micron layer of uranium (4 mg/cm^2) behind one inch of steel was achieved. A prototype system for use in field tests was assembled, and two field demonstrations of the system were carried out. Based on feedback from the demonstrations, the system is being improved. Opportunities for inclusion in a Large Scale Demonstration are being explored.

Progress

On January 13, Trent Andes and Matt Beckum of Westinghouse Savannah River Company visited the Nuclear Engineering Laboratory at Iowa State University. While they were here, they observed the K-edge system measuring uranium content in reactor fuel plates. Andes and Beckum are responsible at Savannah River for verifying characteristics of spent nuclear fuel for long-term storage. They expressed interest in the capabilities of the K-edge system and will bring it to the attention of others at Savannah River.

Preparations began for tests of Resource Conservation and Recovery Act (RCRA) metals characterization in sludge. Idaho National Engineering and Environmental Laboratory (INEEL) has developed a set of phantom drums containing known concentrations of Hg, Pb, and Cd in concrete. A set of 14 of these drums is being shipped to Ames Laboratory for evaluation of the K-edge inspection technique.

Discussions were held with Henry Shaw of the Fissile Materials Disposition Program at Lawrence Livermore National Laboratory regarding the possibility of applying K-edge analysis to characterize ceramic materials being considered for immobilization of excess weapons-grade Pu and U. He sent two surrogate ceramic samples for evaluation.

The D&D Focus Area is working on contracts for projects at INEEL, Los Alamos National Laboratory, Savannah River, Mound, and Richland. As soon as points of contact for these projects are established, we will ascertain which projects offer opportunities for application of the K-edge technology.

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

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

Backpack system. The design and assembly of various backpack LIFI components and the control software continued. LIFI subsystems are being tested separately while mechanical design occurs in parallel. The computer hardware will be enclosed in a removable housing mounted on the laser power supply. The wiring harness that connects the laser head to the backpack unit is being designed so that the connections are strain-relieved, easy to attach, and protected from the environment. The three-dimensional CAD drawings were upgraded to reflect all modifications.

Special Technologies Laboratory (STL) worked closely with the laser manufacturer to complete the specifications of the laser components. The laser manufacturer modified an existing power supply design to provide power for the larger laser head used in the LIFI design. Thermal tests by the vendor indicate that existing coolant pump capacity is adequate for the laser head provided that air flow is maximized. They will modify the air inlet and outlet cutouts accordingly.

Unfortunately, the laser delivery date is rescheduled for March 13, which will delay completion of the backpack assembly milestone. However, we received a prototype copy of the backpack power supply unit and are using it to perform as much parallel engineering as possible to compress the post-delivery schedule. This includes integration of several additional computer power supplies into the existing laser power supply. Also, the camera purchased for the backpack system was returned under warranty to the manufacturer. The intensifier was separating from the charge coupled device (CCD) imager, producing a distortion across the image. We do not anticipate additional schedule delays because of this repair.

The existing portable uranium survey tool was modified; changes to the image capture switch have eliminated the occasional spurious "data save."

New technology exploration. As part of this year's work scope, we began a study of new techniques for optical detection of additional materials, particularly heavy metal contaminants. Task three of our technical task plan outlines the potential use of chelates, fluorescent markers, and sequestering materials to signal the presence of nonfluorescent ions such as cesium. Initial contact was made with UOP Molecular Sieves, which will provide STL with a cesium-specific crystalline silicotitanate (CST) ion-exchange resin for optical analysis. Our intent is to characterize the optical absorbance and luminescence properties of CST as a function of cesium uptake to determine the usefulness of CST as a cesium contrast agent for the LIFI system. STL scientists are discussing the possibility of characterizing other resins with Sandia National Laboratory.

Airborne system. System components were sent to the holographic grating vendor for characterization.

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

Progress continued to be slow because critical personnel are unavailable. LIF spectroscopy (LIFS) data analysis is nearly complete. LIFI data analysis, which requires preliminary results from LIFS data, will begin soon. In the LIFS data, random intensity variation of fluorescence peaks is sufficiently high to preclude making any definitive statements on the variation of the intensity of any single peak as a function of experimental parameters. Wavelengths of the three primary fluorescence peaks were measured for all samples and will soon be evaluated. Band ratios were also calculated and are being analyzed; they are expected to show significant results.

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

HCET personnel drafted the new project scope for December 1997 through October 1998 and submitted it to Special Technologies Laboratory for review.

They also drafted a list of issues concerning the continuation of this project. Under the circumstances and because of the inconsistent scope of this project, which has changed four times during its duration, HCET's ability to contribute to this project is being reviewed.

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

We continue to be plagued by problems with the Princeton Instruments (PI) camera system that is a key part of the laser-induced fluorescence spectroscopy (LIFS) system. It had been returned to Princeton in November, and they shipped it to us in January. Unfortunately, we found that the charge coupled device (CCD) camera was incorrectly assembled at the factory, so it was returned again, leaving us still without a system.

Excitation-emission spectra of healthy wheat, soybean, and snap beans were collected. Based on the resulting spectra, the optimum excitation wavelength appears to be near 355 nm, the wavelength of the tripled YAG laser. This is the wavelength we previously selected based on results from other plant species.

We also completed a series of tests on the variability of fluorescence among different leaves of wheat, soybeans, and snap beans. Results indicate: (a) fluorescence on wheat leaves is generally higher at the base of the leaf than at the mid point; (b) lateral bean and soybean leaves have generally decreased fluorescence compared to leaves emerging from the primary stem; and (c) there is an apparent fluorescence difference between the center and the side leaves in bean trifoliates—the center leaf having the greatest uniformity of fluorescence and chlorophyll, while there is an apparent reduction of fluorescence on the inner half of the side leaves.

The work on Bahia grass began. Healthy as well as zinc stressed (0-, 0.4-, 40-, and 80-ppm zinc) plants will be measured. Seedlings were started; transplanting and data acquisition will begin by the first of March, and the Bahia grass study will be completed by the end of the fiscal year. The objective is to measure baseline response as well as to determine if stress in this monocot can be detected using our optical techniques.

The on-site PI, Andy Schuerger, visited Special Technologies Laboratory (STL) to meet other people involved in the project, to learn more about our capabilities and the LIFS and LIF imaging (LIFI) systems, and to participate in a project review.

During his visit, methodologies for weekly sampling of bean and wheat plants with the robotic arm system were discussed. There was concern that the sun angle during data acquisition might invalidate the spectral signatures of the canopies if not standardized.

Short-term and long-term solutions were identified, and the new robot-based research will start on schedule on February 11. The objective of the robotic arm system is to collect data to determine the daily and seasonal variability of spectral reflectance and fluorescence characteristics of leaf canopies grown under a complete nutrient solution. We talked with other STL personnel about the possibility of using a neural net for "learning" the baseline vs. stressed spectral signatures of plants, as part of the task of building a spectral database for healthy plants from which to predict whether a plant under observation is stressed.

Jeff Goheen of CRS Robotics visited EPCOT to perform yearly maintenance on the robot and to train Andy Schuerger on the robot software. Garrett Headley of STL visited EPCOT the same week to install and test new custom data collection software that he wrote, to work with the CRS robotics representative on some programming/interface issues, and to prepare the system software for a new spectrometer that will be installed soon.

The new spectrometer to replace the spectrometer currently mounted on the robot head at EPCOT is being tested and modified at STL. Sensitivity is more than an order of magnitude higher than that of the old system, wavelength coverage is greater (320 nm to 1,000 nm), and the software is better. Per request from EPCOT, another robot-mounted collection optic for the fiber optic that connects to this spectrometer is being constructed; this optic will operate at an 18- to 24-inch standoff and will have a very large field of view.

John DiBenedetto visited Andy Schuerger at EPCOT. Progress was made toward finalizing plans for the upcoming data-takes at EPCOT. LIFI and LIFS (from STL), passive fluorescence spectroscopy (operated by on-site EPCOT team), near infra-red imaging (operated by Dr. Chi Thai from the University of Georgia), and possibly induction kinetics measurements will be made on the representative plants. The joint project will look at the effects of zinc (0, 0.4, 40, and 80 ppm) on bean and wheat plants (pepper was dropped because of space limitations). Parallel to the spectral characterization studies, samples will be taken from plant canopies to measure the anatomical features and biochemical compositions of leaves. Also, measurements will be obtained to determine photosynthetic rates and basic growth morphometrics of zinc-treated plants.

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

A summary of Site Technology Coordination Group (STCG) and Project Baseline Summary (PBS) needs, based on the searches described below, shows that the main radionuclides/elements of concern are fission products (^{137}Cs, ^{90}Sr, ^{99}TC), ^{235}U, ^{238}U, depleted U, transuranic waste (TRU) (^{238}Pu, ^{239}Pu, ^{241}Pu, ^{241}Am), mixed TRU, ^{232}Th, ^{3}H, ^{59}Ni, Co, lead, and Be. The main equipment/facilities that require remote surveillance/characterization are: vessels, pipes, ducts, concrete and metal surfaces, tank waste, waste containers, boxes, bore holes, transportation packages, soil, ground water, buried drums (structural integrity without removing them from the ground), dry canisters (monitoring of structural integrity), and TRU vs. low-level surface contamination segregation.

STCG databases were searched for needs in the area of remote surveillance and radioactive material characterization for the following sites: Savannah River, Los Alamos National Laboratory, Rocky Flats, Richland Operations Office/Hanford, Fernald, Ohio/Mound, Oakland Operations Office/Lawrence Livermore National Laboratory, Nevada Operations Office, Idaho Operations Office, Oak Ridge National Laboratory, and Chicago Operations Office/Princeton Plasma Physics Laboratory.

PBS searches for the following DOE sites were completed: Albuquerque Operations Office, Carlsbad Area Office, Nevada Operations Office, Ohio Operations Office, Richland Operations Office, Rocky Flats Operations Office, and Savannah River Operations Office.

Literature received from technology vendors such as Canberra was reviewed for possible available technologies.

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 scope has been redefined because of limitations in the original work scope. Characterization of gross alpha emission from surfaces using an electret ion chamber (EIC) has been selected as an alternative to the personnel alpha contamination monitor. Such characterization will be applicable at various sites contaminated with alpha-emitting radionuclides, such as Rocky Flats and Savannah River. Both sites have large surfaces contaminated with alpha-emitting radionuclides including uranium and plutonium. The characterization method allows measurement of low levels of alpha contamination, and large surface areas can be measured simultaneously by deploying many ionization chambers. Oak Ridge National Laboratory (ORNL) has evaluated the method as part of a DOE methods compendium. Two chambers with probe areas of 48 cm^2 and 180 cm^2 are commercially available. The chamber with the larger area provides higher sensitivity. Also, sensitive electrets are now commercially available. The results of earlier measurements from ORNL together with our calibrations, particularly for large-area probes and sensitive electrets, will enable us to deploy the EIC for alpha contamination on surfaces at DOE sites.

A protocol for development and testing at a DOE site was developed. In addition, EICs and standard electrets were procured, and samples of sensitive electrets were obtained.

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

Work this month included compilation of the decontamination technology and radiation sensor information gathered during previous months. Specifically, an Access database that contains all related information on these technology categories was created. The database can be queried to produce specific reports according to the user-specified constraints (i.e., list all technologies that employ mechanical contaminant removal).

Preliminary discussions were held with a characterization technology company. The company and technology were identified as being a possible match during the recent X-Change '97 conference. Initial discussions indicate a strong possibility for a successful technology integration and accompanied testing and deployment at a DOE facility. The technology involves simultaneous measurement of several types of radiation, data display at an integrated electronics unit, remote data transmission capability, and physical positioning information.

Preliminary discussions were also conducted regarding the integration of a new technology to measure the amount of contaminant removed (depth removed measurements).

Work continued on locating potential end users.

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

Program Coordination

CMST-CP Field Program Coordination at Concurrent Technologies Corporation

Objective

This project provides expert technical program integration and field coordination for the Characterization, Monitoring, and Sensor Technology Crosscutting Program (CMST-CP). It is focused on strategizing the CMST-CP technology development multi-year program plan and developing a road map that guides the plan implementation. The road map process consists of the following elements: identifying technology needs; assessing technology requirements, capabilities, and limitations with respect to meeting the identified needs; prioritizing technology development activities according to the impact of overall cost savings for DOE sites; soliciting and promoting development of technology solutions in high-priority technology deficiency areas; monitoring technical progress of projects; and promoting technology deployments to meet site 2006 Plan objectives.

Progress

CMST-CP kickoff meeting. Paul Wang participated in the CMST-CP kickoff meeting in Las Vegas on January 6 and 7. During the meeting, he presented information about facilitator roles, responsibilities, and duties, Site Technology Coordination Group (STCG) needs assessment and prioritization, the CMST gap analysis report, and the multi-year program plan.

Support for CMST-CP program management:

- As requested, Wang briefed Chuck Nalezny and Catherine Klusek on January 22 on CMST-CP FY97 and FY98 performance metrics and accomplishments, as well as other CMST-CP FY98 initiatives.
- At the request of Dave Hippensteel, Wang provided information regarding his transition to Concurrent Technologies Corporation (CTC) and the related benefits to the CMST-CP program. A statement of work for the CMST-CP field coordination project at CTC was prepared and submitted on January 26.
- Wang completed review of the Science and Technology Tables in the Savannah River Site 2006 Plan and forwarded recommended changes to the CMST team regarding deployment and cost savings information on all CMST-related technologies.

Symposium. Wang presented an invited paper on "Sensor Technologies for Environmental Applications at DOE Sites" at the Nevada Science and Technology Symposium on January 8 and 9. The paper was also submitted for publication in the proceedings.

Publications:

- Tiffany Zachry, PAI CMST team member, and Wang prepared the December 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).
- Two extended summaries were accepted for presentation at Spectrum '98: "Evolution of Characterization and Monitoring Technologies for Groundwater and Soil" by Wang and "A Streamlined Process for Facilitation Characterization" by Wang, Mitchell Erickson of Environment Measurements Laboratory, and Holmer Dugger of ICF Kaiser International.

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

Characterization Crosscutting Program Technical and Programmatic Support at Special Technologies Laboratory

Objective

This project provides field technical and programmatic 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

Kickoff meeting. Team members Paul Hurley, Dave Roelant, and Stephan Weeks participated in the CMST-CP kickoff meeting in Las Vegas on January 6 and 7. During the meeting, they presented the progress of the projects to which they are assigned as facilitators and technical monitors. Weeks also presented information about the status of the CMST-CP Internet pages.

Support for CMST-CP program management:

- Roelant collected information about the technology development needs from 11 DOE field offices and coordinated the CMST-CP response to all 11 site deployment plans. Hurley and Weeks reviewed plans from the Chicago Operations Office and the Oakland Operations Office, respectively; they jointly reviewed the Albuquerque Operations Office plan. Roelant reviewed the Richland and Nevada plans; he also reviewed the analyses of site plans that other CMST team members submitted. Information is being shared with the sites.

- Hurley and Weeks completed the technology summary sheet (TSS) documents for their assigned projects. Roelant supported creation of TSS documents for each technology being developed by the CMST-CP in FY98 and reviewed the completed documents.
- In response to a request from the U.S. General Accounting Office, Roelant drafted descriptions of technologies available for deployment at DOE sites with an emphasis on Lawrence Livermore National Laboratory, Savannah River Site, Fernald, Hanford, and Oak Ridge. Information about specific instances of sites turning down applicable technologies was requested and provided.
- Hurley, Roelant, and Weeks began reviewing and updating the TMS database for all CMST funded projects.
- Roelant finalized Performance Metrics for FY98.
- Roelant reviewed information on the Canyon Deployment Initiative at Hanford and also reviewed the SeaLevel technology (automated level monitoring in tanks) Gate 4 review document
- Roelant coordinated review and other activities with all Site Technology Coordination Groups.
- Roelant collected information about seven characterization technologies for the CMST or Nevada Field Office.
- Roelant attended a strategic planning workshop with headquarters (HQ) and field program managers at DOE HQ on January 21 and 22. He also supported development of the CMST-CP presentation for the January 23 business review meeting and attended the meeting.
- Hurley, Roelant, and Weeks reviewed CMST program milestones and provided explanations for cost and schedule variances.
- Hurley, Roelant, and Weeks participated in the January CMST-CP team conference calls.
- Roelant met with Waste Policy Institute personnel to work out issues regarding missing or inaccurate contact information for commercialization and technology deployment.

Cost savings reports. Regarding BetaScint, Weeks continued to coordinate the effort to provide funding for work at Pantex in order to obtain valuable and accurate cost savings data for the development of the Innovative Technology Summary Report. Weeks participated in discussions with Lee Jackson, Amarillo Office; he also received information on an opportunity to deploy BetaScint at the Laboratory for Energy-related Health Research (LEHR) site at the University of California - Davis from Alan Schilk of BetaScint, Inc.

Technical monitor. In his role as technical monitor for the "Automated Monitoring System for Fluid Level and Density in High-Level Waste Tanks" project, Weeks discussed implementation of SEAlevel systems at Savannah River Site with Tom Thomas of the Tanks Focus Area (TFA), Ron Staubly (FETC COR), Glenn Bastiaans (CMST-CP liaison with the TFA), and George Weeks, the Savannah River Site technology user and point of contact. He arranged a meeting and conference call with the above participants at the start of phase 2 funding.

Hardcopy and electronic publications:

- Tiffany Zachry, PAI CMST team member, and Paul Wang of Concurrent Technologies Corporation prepared the December 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).
- Zachry submitted highlights regarding CMST-related activities for consideration of inclusion in the OST Weekly Highlights publication.

Meetings:

- Hurley attended a meeting on Remote Handled Waste Nondestructive Assay in Idaho Falls on January 29 and 30.
- Roelant gave a talk and led a panel discussion on barriers to technology deployment at DOE and non-DOE sites at the Nevada Science and Technology Symposium, January 8 and 9.

PI: Paul Hurley, Special Technologies Laboratory, (805) 681-2472

Characterization Crosscutting Program Technical Support at Ames Laboratory

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).* Haas sent Paul Lemieux of the EPA the complete word processing files and print copy (including the large data appendices) of DOE R&D Report # IS-5128, "Performance Testing of Multi-Metal Continuous Emissions Monitors." Lemieux is pursuing its publication as a joint EPA/DOE report. According to Lemieux, the additional requirements are a quality assurance (QA) review and an administrative (technical editor) review. The QA review is expected to proceed rapidly because the EPA QA section has already reviewed those portions of the paper twice. Haas also sent Lemieux an Adobe Acrobat 3 PDF version of the document. January 12 and 23.
- *September 1997 multi-metals CEMs test at EPA Research Triangle Park (RTP).* At the request of Nina Bergan French, lead author for the report on this work, Haas performed additional review of the draft developer's report, "Microwave Plasma Continuous Emissions Monitor," by Paul P. Woskov et al, Massachusetts Institute of Technology (MIT). Haas provided written feedback to French and Woskov concerning the latter's assertions regarding concentrations at the EPA Reference Method sampling locations and concentrations at his sampling location. Haas and Woskov subsequently discussed and resolved these matters in a telephone conference. January 12.
- Haas carefully reviewed chapter three of the draft report on the September 1997 multi-metals CEMs test and provided written constructive comments and suggestions to the other members of the CEM Working Group, Nina Bergan French, Steve Priebe, and Dan Burns. Haas also provided a draft summary narrative describing the Microwave Induced Plasma configuration and its operation. January 17 and 22.
- *Review of developer report concerning September 1997 multi-metals CEMs test at EPA RTP*. Haas reviewed a draft developer report on this testing, "Internal Calibration Procedure for LIBS," and provided constructive written comments and suggestions to the author, Gary Loge, Laser Diagnostic, LLC, and to Nina Bergan French, lead author for the overall report. January 15.
- *Interagency CEM Technology Development Coordination Committee (ICCC) meeting.* Haas participated in numerous conference calls and other work activities with Steve Priebe, Dan Burns, and Nina Bergan French, members of the CEM working group. The main concern of that work was preparing for the February 11 meeting of the ICCC, involving representatives of the DOE (EM, FE, EE), EPA (OSW, OAQPS, ORD), DoD (Army, Air Force, SERDP), and Electric Power Research Institute.

- *Reviewers for Microwave Induced Plasma (MIP) project.* At Steve Priebe's request, Haas provided a ranked list of 10 potential technical peer reviewers for the MIP project. Haas provided contact and other information, and network links to other information regarding professional qualifications. January 21.
- *EPA Notice of Data Availability (NODA).* At the request of David Eaton, MWFA, Haas reviewed the NODA that the EPA issued for mercury and particulate matter CEMs on December 30. Haas provided written technical comments to Eaton, Peggy Knecht, and Steve Priebe on January 27. Eaton and Knecht combined Haas' comments with others they had previously prepared and forwarded them all to Ted Koss, the DOE HQ officer coordinating the DOE response to the EPA.
- *WM '98 paper.* Haas incorporated summary results from the September 1997 multi-metals CEMs tests at the Toxic Substances Control Act (TSCA) incinerator and at the EPA Rotary Kiln Incinerator Simulator facility into the final draft of the subject paper, "Overview of Development in Continuous Emissions Monitoring for Mixed Waste Treatment." Those results were not available before the WM '98 deadline for submission of the draft paper, but they can be included before the February 2 publication deadline. Haas forwarded the draft paper to Jim Dunn, who provided the TSCA incinerator data, and to the co-authors for review and comment. January 29.
- *Flow Through Alpha Monitor.* Haas forwarded files containing guidance for the preparation of a Technology Performance Report to Russ Gritzo, Los Alamos National Laboratory, PI for the Flow Through Alpha Monitor project. January 16.

CMST-CP technical support to the Tanks Focus Area (TFA):

- *Percent solids monitoring.* Glenn Bastiaans helped Shuh-Haw Sheen prepare a scope of work and a technical task plan (TTP) for developing a prototype ultrasonic percent solids monitor for comparative testing in FY98. Bastiaans suggested milestones for the project and reviewed the proposed TTP. Bastiaans provided a recommendation concerning project funding to the CMST leadership. One or more percent solids monitors 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.
- *Comparative testing of tank slurry monitors.* Haas reviewed the portion of the test report dealing with slurry pump current and power measurements and provided constructive comments to Tom Hylton, the PI. In particular, Haas suggested that Hylton investigate correlation of the pump data with slurry density, viscosity, and percent solids, rather than flow velocity. January 15.

- Haas and Bastiaans reviewed the draft test plan, submitted by Tom Hylton, project PI, for the scheduled FY98 radioactive testing of several pipeline slurry monitors. Haas communicated the findings, comments, and suggestions to Hylton via email on January 23. Haas encouraged Hylton to seek review comments from other members of the program committee, in particular those representing the user community. In several discussions with Hylton, Bastiaans and Haas recommended the testing of a commercially available percent solids monitor, the Zellweger Analytics Inc. BTG SMS3000, in addition to the Shuh-Haw Sheen ultrasonic percent solids monitor. The manufacturer of the commercial instrument has indicated a willingness to assist in adaptation of this instrument for the DOE application. A source to fund the $12 K incremental cost to acquire the optimal probe for the instrument must still be identified.
- *SEA tank fluid level monitoring.* At the request of Ron Staubly, FETC, Bastiaans reviewed the gate review document and the proposed FY98 scope of work for the SEA tank fluid level monitoring project. Bastiaans forwarded comments and suggested changes in work scope to Staubly and the CMST leadership. Bastiaans made calls to Stephan Weeks, CMST project facilitator, and Tom Thomas, Tanks Focus Area/CMST liaison, to prepare for a February 5 conference call to discuss the status and optimal work scope for this project.

Support for CMST-CP program management:

- Bastiaans and Haas participated in the CMST-CP kickoff meeting at the DOE Nevada Field Office in North Las Vegas on January 6 and 7. Along with the other CMST-CP facilitators, they presented information concerning the projects they facilitated in FY97 and detailed information on the progress, status, and plans for the CMST projects they are facilitating in FY98. They participated actively in the discussions and established working relationships with the new members of the CMST team.
- Haas and Bastiaans provided input to Dave Roelant to help support the OST response to a request from the General Accounting Office (GAO) for information regarding new technologies that are available but not selected for use at DOE sites. The GAO is investigating deployment of innovative technologies at Hanford, Oak Ridge, Fernald, Savannah River, and Lawrence Livermore National Laboratory. Haas and Bastiaans nominated the following for consideration: Expedited Site Characterization; X-Ray, K-Edge Fluorescence; Long Range Alpha Detection; X-Ray Fluorescence Metal Analyzer; Laser-Induced Fluorescence Imaging; Heavy Cone Penetrometer Truck at Hanford and the new cone penetrometer sensors, e.g., rad sensor; Time Domain Reflectrometry for tank level monitoring; BetaScint; and Remotely Piloted Vehicles for remote sensing. January 9 and 12.

- As requested, Haas provided constructive feedback to Dave Roelant regarding draft slides prepared as CMST input for a two-day Focus Areas and Crosscut Programs strategic planning workshop at DOE OST HQ. January 15.
- As requested, Haas transmitted files incorporating his review of the science and technology aspects of the 2006 Plan data (S&T tables) submitted by the Rocky Flats and Oak Ridge sites to Greg Gmurczyk, SAIC. January 20.
- For the January CMST-CP Business Review, Bastiaans and Haas provided milestone and cost status information for the projects they facilitated in FY97 and in November FY98 to Greg Gmurzyk and Dave Roelant. January 22.
- As requested by Greg Gmurczyk, Haas researched the deployment of the X-Ray Fluorescence Metal Analyzer (TMS# 2001) at Los Alamos National Laboratory. Haas provided the information collected to Gmurczyk on January 30.
- Haas and Bastiaans participated in CMST-CP team conference calls on January 14 and 28. Topics addressed included: team member activities, information needed for preparation of the OST 1998 report to Congress, cost savings analyses, update of the TMS database, Innovative Technology Summary Reports (ITSRs), Technology Summary Sheets, and involvement of DOE personnel from the Environmental Measurements Laboratory (EML) in the program management and technical support activities of the CMST-CP.
- Haas and Bastiaans generated and revised draft Technology Summary Sheets (TSSs) for several projects (Bastiaans, seven projects; Haas, two projects). They transmitted narrative material, including cost savings estimates, to Dave Roelant and graphic images for these projects and others to Greg Gmurczyk, as requested. January 5.
- In response to Greg Gmurczyk's question concerning whether the CMST-CP should publish a TSS on Expedited Site Characterization and another TSS on Ames Laboratory Expedited Site Characterization, Haas suggested it would be better to have only one and submitted a draft TSS that combines the best narrative parts from the two existing TSSs. January 16.
- Bastiaans reviewed the topical report of the initial phase of the SEA Barrier Validation project at the request of Karen Cohen, the FETC COR. Bastiaans submitted a written review to Cohen. Additional funding of this project depends on the outcome of the FETC review.
- Bastiaans and CMST facilitator Bruce Friedrich conferred by telephone with 3M personnel developing the Empore membrane technology to assay and remove radionuclide contaminants from waters at DOE sites. The 3M researchers were concerned about the potential for obtaining additional funding via the FETC industry program for further development of the membrane technology. Friedrich and Bastiaans identified and evaluated the portions of the proposed work that support CMST objectives. Bastiaans and Friedrich submitted a recommendation for

CMST funding of the appropriate portions of the proposed work to the CMST leadership and to Ron Staubly, the FETC COR.

- Bastiaans continued liaison work between the CMST and the Hemispheric Center for Environmental Technology at Florida International University (HCET/FIU). At the CMST kickoff meeting, Bastiaans briefed the CMST Team on the history and status of the HCET/FIU work with EM-50. Possible modes of closer interaction between CMST and HCET/FIU were suggested and are being pursued. Facilitation of collaboration between HCET/FIU and Special Technologies Laboratory (STL) in the area of laser-induced fluorescence imaging for plant stress analysis is continuing.
- Bastiaans continued to communicate with Steve Leffler of General Atomics concerning a planned demonstration of CMST-CP sponsored subsurface VOC monitoring technology in conjunction with a larger demonstration of the E-Smart environmental technology monitoring system developed in a collaboration between DOE EM-50 and the Defense Advanced Research Projects Agency (DARPA) Technology Reinvestment Program. A delay in the production of optical sensors, a technology sponsored by DARPA, will cause a delay in the demonstration to June or July 1998. The demonstration is planned at Tinker Air Force Base. Sawtek, the commercial licensee of the CMST-CP sponsored surface acoustic wave sensor (SAWS)/portable acoustic wave sensor (PAWS) technology, plans to participate in the demonstration.
- Bastiaans recommended projects for review at the CMST mid-year meeting to Paul Wang and Dave Roelant.
- In response to Chuck Nalezny's request, Haas and Bastiaans each identified approximately 20 CMST-CP projects for which they would check and provide updated information for the TMS database update, which is to be completed February 13. They began work on that project on January 27.

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