"INTERNATIONAL ENVIRONMENTAL TECHNOLOGY IDENTIFICATION, DEVELOPMENT, DEMONSTRATION, DEPLOYMENT AND EXCHANGE"

FINAL TECHNICAL REPORT

Period of Performance: 06/28/95 to 11/30/00

DOE Award Number: DE-FC21-95EW55101

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Date of Issuance:

28 February 2001

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Abstract

Cooperative Agreement (DE-FC21-95EW55101) between the U.S. Department of Energy (DOE) and the Florida State University's Institute for International Cooperative Environmental Research (IICER) was designed to facilitate a number of joint programmatic goals of both the DOE and the IICER related to international technology identification, development, demonstration and deployment using a variety of mechanisms to accomplish these goals. These mechanisms included: laboratory and field research; technology demonstrations; international training and technical exchanges; data collection, synthesis and evaluation; the conduct of conferences, symposia and high-level meetings; and other appropriate and effective approaches. The DOE utilized the expertise and facilities of the IICER at Florida State University to accomplish its goals related to this cooperative agreement. The IICER has unique and demonstrated capabilities that have been utilized to conduct the tasks for this cooperative agreement. The IICER conducted activities related to technology identification, development, evaluation, demonstration and deployment through its joint centers which link the capabilities at Florida State University with collaborating academic and leading research institutions in the major countries of Central and Eastern Europe (e.g., Czech Republic, Hungary, Poland) and Russia. The activities and accomplishments for this five-year cooperative agreement are summarized in this Final Technical Report.

INTRODUCTION

During the period 1995-2000, Florida State University conducted research, as well as technology development and deployment activities with the U.S. Department of Energy (DOE) through the Institute for Cooperative Environmental Research (IICER). Since 1995, these activities have been conducted under cooperative agreement DE-FC21-95EW55101 and directed by the National Energy Technology Laboratory (NETL) in Morgantown, West Virginia. NETL provided both technical and fiscal guidance for these international cooperative activities.

The objectives of this five-year cooperative agreement were to accomplish the following:

- To ensure that research and development projects were strategically focused on solving near-term clean-up problems within the DOE complex.

- To focus on technology development and deployment efforts that resulted in "widely deployable" technologies (i.e., OST Focus Area developed technologies that could be successfully deployed for multiple applications throughout the DOE complex).

- To work to ensure close coordination among EM headquarters, DOE-EM technology developers, field offices, contractor officials and end-user organizations within the DOE complex to be sure that technology "tools" were delivered to address specific DOE clean-up problems.

- To adhere closely to the structure of the technology development "gates system" which ensures that "user needs" and "user performance requirements" were closely reflected in subsequent technology development and deployment initiatives.

- To ensure "early" end-user integration in OST Focus Area technology development and deployment planning and implementation.

The IICER conducted solution-oriented activities related to technology identification, development, evaluation, demonstration and deployment through its joint centers which link the capabilities at the Florida State University with leading collaborating academic and research institutions in the major environmental research institutions in Europe, Russia as well as in other parts of the world. The activities conducted for this cooperative agreement allowed for continuity of effort related to these cooperative activities that were on going between the Florida State University and the OST Focus Areas of DOE prior to 1995.

This cooperative agreement focused on the deployment of technologies to assist in cleaning up the DOE complex through the following mechanisms:

- technology identification, development, demonstration, validation and deployment;
- technology integration and technical assistance;
- cooperative environmental technology demonstration/validation in support of the OST Focus Areas;
- data collection, synthesis, evaluation;
- international conferences, symposia and workshops; and
- professional/scientific exchanges of personnel.

An important emphasis of this cooperative agreement involved building upon the strength at Florida State University to organize multi-agency; private-public partnership projects to address shared environmental problems. An example of this strength is the on-going work of the Interagency DNAPL Consortium (IDC) activities at the Kennedy Space Center (see Section XIV of this report). Through this multi-agency initiative, side-by-side demonstrations of DNAPL source zone remediation technologies were conducted jointly by the DOE, EPA, DOD (Air Force) and NASA. The benefits of these multi-agency initiatives include shared cost, shared knowledge, collection of site-specific comparative cost and performance data, accelerated regulatory acceptance of DNAPL technologies, absence of duplication of effort and other related benefits. This model of cooperative engagement was utilized to address other problems shared by DOE, other federal agencies and the private sector, as well as shared agency and private sector problems (e.g., containment technologies, phytoremediation, long-term monitoring, natural attenuation) and to provide solutions.

The following information summarizes the activities conducted during this five-year cooperative agreement between DOE-NETL and Florida State University. The activities and accomplishments of each of the tasks for this agreement are summarized below in the following sections.

SUMMARY OF PROJECTS/ACTIVITIES

I. JCCEM MANAGEMENT AND RESEARCH ACTIVITIES IN RUSSIA

Background

The Joint Coordinating Committee for Environmental Management (JCCEM) directs a program of joint research and technology development that was

established in 1990 between the U.S. Department of Energy and the Russian Ministry of Atomic Energy (MINATOM). This program is managed by Florida State University (FSU) in conjunction with Science Applications International Corporation (SAIC) who conducts programmatic activities under contract to Florida State University. This program involves the conduct of joint projects focused on common or shared environmental clean-up problems involving radioactive and chemical contamination found at both Russian and U.S. DOE facilities and laboratories.

The Joint Coordinating Committee for Environmental Restoration and Waste Management (JCCEM) meets annually to review and approve proposals, assess program progress, make determinations as to the protection of intellectual property rights (IPR) and data transmission, and determine the level of effort for future activities. The 10th JCCEM meeting was held in Prague, Czech Republic on September 13-14, 2001, and the 11th JCCEM meeting will be conducted July/August 2001 in St. Petersburg, Russia.

The first step in the annual cycle of the Russian JCCEM Program is a determination of research and technology deployment needs of the DOE-EM Focus Areas. Based on this information, and after preparation and distribution of appropriate RFPs, proposals are solicited from Russian institutions in conjunction within MINATOM. Joint proposals are then developed which have been approved by MINATOM. Over the past ten years, in order to ensure that the proposals that are provided are consistent with the objectives of the DOE-EM Focus Area Managers, it has been necessary to coordinate with the Russian institutes during the proposal preparation period. This includes presenting information on the technology development needs of the DOE Focus Areas to Russian scientists and communicating the priorities of the technology development managers. In previous years, our experience has been that proposals are submitted from multiple sources and it is necessary to ensure that all of the proposals that are submitted have been approved for consideration by MINATOM. After the proposals have been received, they must be cataloged according to technology area and distributed to the respective DOE-EM Focus Area Managers for review. An annual JCCEM Meeting is then organized with the DOE-EM Focus Area Managers and MINATOM officials in order to select those projects that are to be funded by DOE during the subsequent fiscal year. It is also necessary to coordinate with participating Russian scientists on an on-going basis in order to clarify issues, resolve problems, answer questions, discuss aspects of reviewing and awarding projects and coordinate logistically JCCEM workshops, demonstrations and scientist visits to DOE sites and facilities.

The IICER has provided programmatic and technical support to DOE in the development of JCCEM Statements of Work, Records of Meeting, and publications. Through regular contact with Russian and U.S. principal investigators, the IICER assures that projects run smoothly and that technical issues are resolved. The IICER also plays a role in helping the Deactivation and Decommissioning Focus Area establish contact with potential DOE end-users of Russian D&D technologies, and assists the Subsurface Contaminants Focus

Area in identifying Russian scientists with expertise in vadose zone issues in the development of this new area of cooperation.

The work for this project involves both technical and logistical components. Effective interactions between DOE scientists and Russian scientists requires both translational skills and a technical understanding of these joint projects in order to ensure that both sides understand the scopes of work for projects, deadlines and deliverables. Senior scientists at Florida State University have provided most of this translational and technical capability. The JCCEM Program includes a number of technical workshops and technology demonstrations each year. The logistical arrangements to successfully execute these events can be extensive (e.g., organizing meeting facilities, travel for Russian scientists, preparing meeting documents and subsequent contracts for joint projects). Most of the logistical work for this program is provided by SAIC under contract to Florida State University.

Project Publications

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Development and Demonstration of the Universal Solvent Extraction Process for the Simultaneous Separation of Cesium, Strontium, and the Actinides from Actual Highly Radioactive Waste. J. D. Law, R. S. Herbst, T. A. Todd, D. J. Wood, V. N. Romanovskiy, V.M. Esimantovskiy, I. V. Smirnov, V. A. Babain, B. N. Zaitsev, In Proc. of Waste Management 2000, Tucson, Arizona, USA, Feb. 27 -March 2, 2000.

A New Porous Crystalline Matrix (Gubka) for Stabilizing Actinide Solutions. D.A. Knecht, T.J.Traner, A.G. Anshits, A.A. Tretyakov, A. S. Aloy and J. Macheret. (About 9 pages, 1 reference). In Proc. Waste Management 2000 Symposium, Tucson, Arizona, USA, Feb.27- March 2, 2000.

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Assessment of the Hydrological Parameters in Heterogeneous Anisotropic Fractured Rock: Part 2. Field Determination of the Three-Dimensional Hydraulic Conductivity Tensor of Anisotropic Media. Alexandrova O.N., E.G. Drozhko, P.M. Stukalov, L.M. Samsonova, A.V. Glagolev, A.Hutter, H Wollenberg *(in preparation).*

Radioactive Contamination Distribution in the Bottom Sediments and Water of the Mishelyak River. E. G. Drozhko, Y. V. Glagolenko, Y. G. Mokrov, A.

Posokhov, G. Romanov, K. Stevenson, I. Volkanina, and A. Hutter. Journal of Radioanalytical and Nuclear Chemistry (accepted for publication).

Development and Calibration of a Three-Dimensional Regional Hydrogeologic Model for the Mayak Site, Urals. PNNL-SA-32508. Cole, C.R., K.A. Hoover, M.G. Foley, M.D. Williams, E. Drozhko, L. Samsonova, N. Vasil'kova, A. Zinin, G. Zinina, and K. Ter-Saakian. Hydrological Science and Technology Short Papers, American Institute of Hydrology (in review).

Development and Demonstration of Solvent Extraction Processes for the Separation of Radionuclides from Acidic Radioactive Waste. J.D. Law, R.S. Herbst, K. N. Brewer, T.A. Todd, and D. J. Wood, Waste Management, 19, pp. 27-37 (1999).

Demonstration of the UNEX Process for Simultaneous Separation of Cesium, Strontium, and the Actinides from Actual INEEL Tank Waste. J.D. Law, R.S. Herbst, T.A. Todd, V.N. Romanovskiy, V.M. Esimantovskiy, I.V. Smirnov, V.A. Babain, B.N. Zaitsev , M.V. Logunov. (About 28 pages, 12 references). Idaho National Engineering and Environmental Laboratory Report: INEEL/EXT-99-00954, October 1999.

Demonstration of the Universal Solvent Extraction Process for the Separation of Actinides, Cesium, and Strontium from Actual Acidic Tank Waste at the Idaho National Engineering and Environmental Laboratory. J.D. Law, R.S. Herbst, T.A. Todd, V.N. Romanovskiy, V.M. Esimantovskiy, I.V. Smirnov, V.A. Babain, B.N. Zaitsev. (About 8 pages, 2 references). In Proc. of the 4th International Conference on Future Nuclear Systems (GLOBAL '99), Jackson, WY, 1999.

Development of a Universal Cobalt Dicarbollide Solvent for the Removal of Actinides, Cesium and Strontium from Acidic Wastes. T. A. Todd, V. N. Romanovskiy, K. N. Brewer, J. D. Law, R. S. Herbst, D. J. Wood, V. M. Esimantovskiy, I. V. Smirnov, V. A. Babain and B. N. Zaitsev. In Proc.. of the International Solvent Extraction Conference (ISEC '99), Barcelona, Spain, 1999.

Development of a Universal Solvent for the Decontamination of Acidic Liquid Radioactive Wastes. T. A. Todd, V. N. Romanovsky, K. N. Brewer, J. D. Law, R. S. Herbst, V. M. Esimantovsky, I. V. Smirnov, V. A. Babain, B. N. Zaitsev. Czech Journal of Physics, 49 (1999).

Applicability of the Russian Separation Technology to Processing of US Radioactive Waste. V.N. Romanovsky, V.A. Babain, V.M. Esimantovsky, B.N. Zaitsev, I.V. Smirnov, D.N. Shishkin. (53 pages). Khlopin Radium Institute Report N 2779-i, November, 1999.

Development of Alkaline Oxidative Dissolution Methods for Chromium (III) Compounds Present in Hanford Site Tank Sludges. N. N. Krot, V.P. Shilov, A. M. Fedoseev, N.A. Budantseva, M.V. Nikonov, A.B. Yusov, A.Yu. Garnov, I.A. Charushnikova, V.P. Pewrminov, L.N. Asrtafarove, T.S. Lapitskaya, V.I.

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Uranium, Plutonium, and Americium Behavior in Alkaline Treatment of K Basin Sludge Dissolver Solution, N.N. Krot, A.B. Yusov, V.P. Shilov, N.A. Budantseva, A.Yu. Garnov, T.S. Lapitskaya, T.A. Flament, and C.H. Delegard. 23rd Annual Actinide Separations Conference, June 7-10, 1999, Kennewick, WA.

Installation of the Russian Hybrid Plasma Induction Cold Crucible Melter at the Diagnostic Instrumentation & Analysis Laboratory. Dana McGee Miles, William Gene Ramsey, John Plodinec. (14 pages, 5 references). Diagnostic Instrumentation and Analysis Laboratory Report: DIAL 40395, TR 98-2, February 1999.

Low-Temperature Chemically-Bonded Iron Phosphate Ceramics for Radioactive Waste Management. A. S. Aloy, E. Kovarskaya, T. Koltsova, J. Macheret and T. A. Todd, In Proc. of the 4th International Conference on Future Nuclear Systems (GLOBAL '99), Jackson, WY, 1999

Development and Testing of a New Porous Crystalline Matrix (Gubka) for Stabilizing Actinide Solutions. A. S. Aloy, A.G. Anshits, A.A. Tretyakov, D.A. Knecht, T.J.Traner and J. Macheret. (About 7 pages, 9 references.). MRS '99 Report (Boston) (in press).

Russian/American Subsurface Contaminant Transport Studies Around Lake Karachai. E. Drozhko, M. Glinsky, A.V. Glagolev, A. Alexahkin, I. A. Ivanov, A. A. Poshokov, B.B. Looney, R. L. Nichols, A. R. Hutter. Proceedings of the Fourth International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe (Warsaw '98), Florida State University, Tallahassee, Florida, 1999.

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Chemical Separation Technologies and Related Methods of Nuclear Waste Management: Applications, Problems and Research Needs, Eds. G.R. Choppin

and M. Khankhasayev, Kluwer Academic Publishers, NATO Science Series, Dordrecht, The Netherlands, 1999.

Technologies for Nuclear Separations: A Look to the Future, Eds. G.R. Choppin, M. Khankhasayev, and H. Plendl, 2001.

Major Project Accomplishments

In 1999, the Deactivation and Decommissioning Focus Area (DDFA) issued contracts to six Russian organizations: All Russian Project and Scientific Research Institute of Complex Power Technology (VNIPIET), The Research and Development Institute of Construction Technology (NIKIMT), Mayak Production Association, Mining and Chemical Combine, Siberian Chemical combine, Urals Electrochemical Combine,to evaluate commercially available Russian D&D technologies for applicability to the needs of the DDFA's Large Scale Demonstration and Deployment Projects. The Russian end-users and technology developers were asked to prepare summaries on technologies with which they have worked, including performance data. Fourteen technology summaries were reviewed by the DDFA. The LSDDP at Los Alamos National Laboratory (LANL), Idaho National Environmental and Engineering Laboratory (INEEL) and the Mound Facility expressed interest in demonstrating the following four technologies at their sites:

1. The distance method for the determination of activity density distribution on a surface, NIKIMT, Moscow, Russia.

2. Deactivation of radioactive contamination through removable coatings, NIKIMT, Moscow, Russia.

3. Deep decontamination of plutonium glove boxes (electrochemical method of strongly fixed contaminants, VNIPIET, St. Petersburg, Russia.

4. Decontamination of plutonium glove boxes (foam method of removal of slightly fixed contaminants), VNIPIET, St. Petersburg, Russia.

A new call for joint U.S.-Russian cooperative D&D proposals in Basic Science Research and Applied Research has been initiated and will be distributed in March of 2001.

The IICER was heavily involved during the 1999-2000 period in the initiation of Identification and Evaluation of Promising Case Studies on the Vadose Zone Contamination and Remediation Problems in Russia. Field characterization and monitoring at sites across the DOE complex have identified a need for monitoring technologies, and predictive simulations to quantify flow and contaminant transport in the vadose zone in order to properly predict long-term performance and manage waste disposal sites. The integration of studies on radioactive and hazardous waste migration of chemical and nuclear waste from disposal sites in

Russia into the DOE program could offer timely and effective solutions to these pressing issues.

A first project, Identification and Evaluation of Promising Case Studies on the Vadose Zone Contamination and Remediation Problems in Russia, was initiated in January 1, 2000. The goal of this project is to identify and evaluate a series of case studies, including data on monitoring, characterization fate/transport, numerical modeling, and remediation of chemical and nuclear waste disposal sites in the vadose zone in Russia. These case studies will be used to supplement U.S. technologies and numerical models at DOE sites and to support the U.S. DOE Vadose Zone Roadmap efforts. This project was completed successfully, and the second cooperative project on this topic was initiated in January 1, 2001.

Presentations at Key Conferences, Symposia

December 13-14, 2000; Joint US -Russian JCCEM Workshop on Decontamination of Plutonium Gloveboxes; Miamisburg, Ohio, USA.

December 11-12, 2000; Joint US-Russian JCCEM Workshop on Tritium D&D Technology, Miamisburg, Ohio, USA.

November 5-8, 2000; Modeling and Vadose Zone Workshops in Conjunction with the 2000 Annual Meeting and International Conference of the American Institute of Hydrology.

September 13-14, 2000; The 10th Meeting of the Joint Coordinating Committee for Environmental Restoration and Waste Management (JCCEM), Prague, Czech Republic.

June 11-16, 2000; Joint U.S.- Russian Deactivation and Decommissioning Workshop in conjunction with the DOE International Decommissioning Symposium (IDS 2000), Knoxville, Tennessee, USA.

May 16-18, 2000; 2nd Users-Developers High Level Waste Tank Remediation Workshop, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho, USA.

July 7-21, 2000; Workshop and Demonstration of the Cobalt Dicarbollide Universal Extraction (UNEX) Technology, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho, USA.

July 5 - Aug 1, 2000; Joint U.S. -Russian JCCEM Workshop on Contaminant Transport Modeling, Pacific Northwest National Laboratory, Richland, Washington, USA.

July 18-20, 2000; Joint U.S. - Russian JCCEM Induction-Heated Cold Crucible Melters Technology Workshop, Santa Fe, New Mexico, USA.

June 1-18, 2000; Joint U.S.- Russian Workshop and Demonstration of the Crystalline Porous Silica ("Gubka") Technology, Khlopin Radium Institute, St. Petersburg, and Mining Chemical Combine, Zheleznogorsk, Russia.

April 29-May 6, 2000; Joint U.S. - Russian JCCEM Workshop on Cobalt Dicarbollide Universal Extraction (UNEX) Technology, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho, USA.

April 17-20, 2000; Joint U.S.-Russian Workshop on Detailed Evaluation of the NIKIMT Strippable and Non-Strippable Coatings for Possible Demonstration at the Mound DOE Facility, Miamisburg, Ohio, USA.

March 6-10, 2000; Joint U.S. – Russian JCCEM Workshop/Demonstration on the Crystalline Porous Silica “Gubka” Technology, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho, USA.

March 6-17, 2000; Joint U.S. -Russian JCCEM Workshop on Contaminant Transport Modeling, Pacific Northwest National Laboratory, Richland, Washington, USA.

March 18-25, 2000; Joint U.S./Russian Meeting on Distance Method for Determining Activity Density on a Surface: Exploring the Possibility of Combining the NIKIMT-Developed Gamma Locator Device with an Existing INEEL Robotic Platform, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho, USA.

February 27 - March 3, 2000; Joint U.S./Russian Meeting on Distance Method for Determining Activity Density on a Surface and Demonstration of the NIKIMT-Developed Gamma Locator Device, Research and Development Institute of Construction Technology Moscow, Russia.

Inventions, Patents, Licensing Agreements

2000

U.S. patent granted in June of 2000 for the Iron Phosphate Ceramics technology (Patent no. 6,075,176).
U.S. patent applications filed in March 2000 for the UNEX solvent and processes (S-88,810; S-89,026).
U.S. patent applications for the GUBKA material and processes filed in November 2000 (S-95,927; S-96,062).

1999

U.S. patent granted in March 1999 for the PICCM apparatus (Patent no. 5,882,581).

1998

U.S. patent granted in May 1998 for PICCM processes (Patent no. 5,750,822).

1997

U.S. patent granted in June 1997 for the Actinide Chemistry technology (Patent no. 5,640,668).

Success Stories

The Cobalt Dicarbollide Universal Solvent Extraction (UNEX) Technology was developed by the Khlopin Radium Institute for removing cesium, strontium, and actinides from acid waste in a single-step process. The UNEX process is a promising separations technology with potential application at several DOE sites, including the Idaho National Engineering and Environmental Laboratory. Currently, UNEX is included in the Idaho Environmental Impact Statement as an alternative to the baseline technology.

The Russian Pneumatic Pulsating Pump and Monitor is a new technology developed by the Institute for Physical Chemistry for the retrieval of high-level waste (HLW) from storage tanks at DOE sites. The pulsating pump was demonstrated successfully at the Quarter-Scale Tank Test Facility at Hanford in July 1997 in order to determine the capabilities, limitations, and suitable applications of the tank retrieval equipment at U.S. sites. As a result of successful U.S. and Russian demonstrations, three sets of the Russian equipment were procured in November 1998. The pump and monitor were successfully deployed in Oak Ridge tanks in October 2000.

The Plasmatron with Induction Cold Crucible Melter (PICCM), developed by the Khlopin Radium Institute, is a pilot-scale apparatus for the treatment of solid mixed radioactive wastes. In laboratory and pilot scale tests, the device has immobilized mixed waste streams at both the Diagnostic Instrumentation and Analysis Laboratory (DIAL) at Mississippi State University and the Georgia Institute of Technology. PICCM continues to be used at DIAL for spent fuel applications testing.

The Porous Crystalline Matrix for Stabilizing Actinide Solutions (GUBKA) technology, developed by the Khlopin Radium Institute**,** the Mining and Chemical Combine, and the Institute of Chemistry and Chemical Technology, is manufactured from coal power plant fly ash for the stabilization of actinide solutions at ambient temperature. This technology is currently being considered by several DOE sites for applicability to stabilizing laboratory wastes and the adsorption of radioactive acidic wastes.

Modeling activities, conducted by Russian and American specialists from the Mayak Production Association, Hydrospetzgeologiya, the DOE Environmental Measurements Laboratory, and the Pacific Northwest National Laboratory, are assisting DOE in the development of an inverse transient model of contaminant migration at the Hanford site by the regulatory deadline in 2001.

II. DEVELOPMENT AND MAINTENANCE OF INTERNATIONAL PROGRAM WEB PAGES

Background

As one effective method of disseminating information about the activities of DOE's International Programs, a series of Internet web pages were developed by Florida State University. These web pages provide summary information on the JCCEM, JCCES and JCCRM Programs, the projects conducted under these programs, contact information for non-U.S. and U.S. scientists involved with these programs and other pertinent information on publications and other related programmatic activities (e.g., workshops and technical exchanges) for each program. The objective of this task was to develop and maintain a series of Internet web pages.

During the last five years, Florida State University was responsible for implementing and maintaining the JCCEM, JCCES, JCCRM and other DOE International Program web pages. The IICER Webmaster maintains these pages on a server at Florida State University. The Internet addresses for these web sites are:

JCCEM Program Web Site: **http://www.jccem.fsu.edu**

JCCRM Program Web Site: **http://www.jccrm.fsu.edu**

JCCES Program Web Site: **http://www.jcces.fsu.edu**

To learn more about DOE's International Programs, please visit these sites.

III. TECHNICAL LIAISON RESEARCH ACTIVITIES IN ARGENTINA

Background

In 1996, DOE and the National Atomic Energy Commission of the Argentine Republic (CNEA) signed a cooperative agreement in the area of radioactive and mixed waste. The Agreement is managed by the Joint Coordinating Committee for Radioactive and Mixed Waste Management (JCCRM). The JCCRM meets annually to review and approve proposals, assess program progress, and evaluate potential future activities. The Fifth JCCRM was held in Augusta, Georgia in November 2000.

The Joint Coordinating Committee for Radioactive Waste Management (JCCRM) directs a program of joint research and technology development between the U.S. Department of Energy and the Government of Argentina. This program is managed by Florida State University (FSU) in conjunction with Science Applications International Corporation (SAIC) who conducts programmatic activities under contract to Florida State University. This program involves the

conduct of joint projects focused on common or shared environmental clean-up problems involving radiological contamination found at both Argentine and U.S. federal facilities and laboratories.

This task was designed to build on the concept and experience of the Russian JCCEM program to identify and access environmental expertise in Argentina and neighboring countries related to radioactive waste management. This task utilized the experience base of SAIC to establish a technology identification and development program for the Focus Area managers of DOE/EM and provide on-going liaison between the Focus Area Managers and environmental scientists from Argentina. This task was designed to develop and implement a strategy to identify promising environmental technologies using, as a template, the Russian JCCEM Program vis-a-vis the environmental ministry and other key contacts in Argentina.

This task is designed to build on the concept and experience of the Russian JCCEM program to identify and access environmental expertise in Argentina and neighboring countries related to radioactive waste management. FSU utilized the experience base of SAIC to establish a technology identification and development program for the Focus Area managers of DOE/EM and provide on-going liaison between the Focus Area Managers and environmental scientists from Argentina. The objectives of this task were:

- To identify and access environmental expertise in Argentina and neighboring countries related to radioactive waste management.

- To use the experience base of SAIC to establish a technology identification and development program for the Focus Area managers of DOE/EM and provide on-going liaison between the Focus Area Managers and environmental scientists from Argentina.

Under sub-contract to the Florida State University, SAIC developed annual scopes of work to implement the directives of the JCCRM Program in Argentina related to radioactive waste management. These annual work plans served to establish a technology identification and development program for the Focus Area managers of DOE/EM and provide on-going liaison between the Focus Area Managers and environmental scientists from Argentina.

Major Project Accomplishments

DOE and CNEA collaborated on the Spent Ion Exchange Resins project, which evaluates the potential use of vitrification as a method for treating spent resins. The JCCRM sponsored three workshops in conjunction with this project, held at the Clemson Environmental Technologies Laboratory in February and July 1999 and at the Pacific Northwest National Laboratory in August 2000. During the 1999 workshops, cesium-doped resins from two Argentine nuclear plants, Atucha and Embalse, were vitrified and off-gas and other operational data were collected. Additional melter studies using Atucha and Embalse resins that had

been doped with inactive cesium, strontium, and cobalt were performed during the 2000 workshop. The next demonstration is planned for May 2001 at Savannah River Technology Center.

DOE and CNEA collaborated on the Molybdenum-99 (Mo-99) project, which included an evaluation of the use of the inorganic selective ion exchange material Crystalline Silicotitanates (CST) to remove cesium from the Mo-99 waste stream. By reducing cesium concentrations, the bulk of the Mo-99 waste stream can be disposed of as a low-level waste. In 1997, analysis of CNEA's Mo-99 waste streams indicated that CST could provide the decontamination factors needed for low-level waste classification. From 1997-1999, multiple options were evaluated combined with computer modeling of the application. Future project activities include the evaluation of crown ethers and other absorbers to remove cesium as well as strontium from the Mo-99 waste stream.

At the Fifth JCCRM meeting, DOE and CNEA agreed to several new cooperative projects. DOE and CNEA agreed to collaborate on two Tanks Focus Area projects: Double Shell Tank Corrosion Chemistry and In-Situ Sampling Project. The Subsurface Contaminants Focus Area agreed to collaborate with CNEA on two projects: Physics of Fracture Flow and Transport in the Vadose Zone and Low Level Waste Trench Issue. The Deactivation and Decommissioning (D&D) Focus Area plans to hold a planning workshop in May 2001with CNEA to discuss future collaborative D&D projects.

IV. JCCES MANAGEMENT AND RESEARCH ACTIVITIES IN CENTRAL AND EASTERN EUROPE

Background

The Joint Coordinating Committee for Environmental Systems (JCCES) directs a program of joint research and technology development between the U.S. Department of Energy and the Institute for Ecology of Industrial Areas (IETU - Polish Acronym). This program is managed by Florida State University (FSU) in conjunction with Science Applications International Corporation (SAIC) who conducts programmatic activities under contract to Florida State University. This program involves the conduct of joint projects focused on common or shared environmental clean-up problems involving chemical contamination found at both Polish and U.S. federal facilities and laboratories.

Over the past five years, a series of joint projects have been conducted with the IETU that is located in Katowice, Poland. This institute and this region of Poland have been of interest to the DOE in the context of extensive and long-term experiences related to heavy metals contamination of soils and other forms of organic contamination resulting from the intensive industrial activities conducted in southern Poland. Southern Poland is rich in non-ferrous metal alloys which have been mined, and continued to be extracted and processed, resulting in widespread and serious contamination of soils and groundwater throughout the

region. Over the past 40-50 years, heavy industry has also been developed in this region of Poland using these mineral resources as feedstock to foundries, metal fabricating plants and other heavy industry which has also contributed greatly to the overall environmental contamination of this part of Poland. DOE which also has problems with heavy metals and other forms of contamination through the DOE Complex has viewed the IETU and its surrounding environs as a "test bed" for evaluating and demonstrating new, lower cost technologies. The IETU is one of Central Europe's leading environmental research institutes having excellent laboratory facilities and scientific personnel who have made outstanding partners for the projects undertaken for this cooperative agreement. Beyond the excellent quality of the scientific staff, the relative cost of conducting projects in Poland vs. the United States is about half, including direct and indirect costs

The first technical focus of these joint projects was on developing a phytoremediation technology that could be implemented cost-effectively at full field scale using conventional agricultural practices and equipment. These projects were conducted in support of the Subsurface Contaminants Focus Area and consisted of the following activities:

- Cost-Effective Phytoremediation Using Computerized Application of Soil Amendments.

- Development of a Specialized Chlorophyll Fluorometer for Optimizing the Phytoremediation Process.

- Site Characterization and Site Treatability Studies

Results from earlier IETU phytoremediation field studies indicate that approximately 60% of the cost of phytoremediation are associated with the procurement and application of soil amendments. It is estimated that amendment application rates could be reduced by as much as 50% using a computer-based approach, yielding an overall reduction of up to 30% of the cost of phytoremediation. The computerized application of soil amendments promises to be a cost-effective technology by minimizing the quantity of amendments applied. Since the need for amendments is a function of soil metal concentration and speciation, it is possible to minimize the use of amendments if information concerning the nature and distribution of soil metals is used to control the application of amendments. The automated amendment application technology that has been developed by the IETU for full field scale application was modified to accept computerized input to control amendment application rates.

The second technical focus of these joint projects was on developing a bioremediation technology that could be implemented cost-effectively and modified to be used as a mobile bioreactor at DOE sites. These projects were also conducted in support of the Subsurface Contaminants Focus Area and consisted of the following activities:

JCCES Bioremediation Projects in Poland (Molecular Characterization of Acidophilic Microorganisms Capable of Degrading Petroleum Hydrocarbons, Production-Scale Implementation of Petroleum Contaminated Soils Bioreactor, Bioremediation of Nitroaromatic Compounds)

JCCES Heavy Metals Remediation Project in Poland (*In Situ* Reactive Zones for Removal of Mercury from the Subsurface)

This overall project involved the implementation of three projects related to bioremediation to be conducted in Poland. The first bioremediation project involves the molecular characterization of acidophilic microorganisms, which have been proven to be capable of degrading petroleum hydrocarbons. The second bioremediation project involves a promising technology for removing organic contaminants from soil. On-going research conducted by the IETU at the Czechowice Oil Refinery (COR), Poland has demonstrated significant advances in this technology. These advances have resulted in reductions in the cost, time and complexity, while improving the efficiency of bioremediation for soils contaminated with petroleum hydrocarbons. Further refinements are needed in order to optimize the applicability of this technology. The third bioremediation project involves the remediation of nitroaromatic compounds. Nitroaromatic compounds are widely used as pesticides, explosives, solvents, and intermediates in the synthesis of dyes and other high volume chemicals. Many of these compounds and their transformation products are of significant environmental concern. Contamination of soil and groundwater with nitroaromatic munitions residues such as 2,4,6-trinitrotoluene (TNT) and other nitro- and aminonitrotoluenes have recently drawn considerable public attention. DOE, in conjunction with the Tennessee Valley Authority, owns or manages many former munitions sites that previously belonged to DOD or private munitions manufacturers east of the Mississippi River. DOE sites with solvent contamination of soils and groundwater will be the beneficiaries of this work.

The final aspect of this overall project involved the implementation of a project related to remediation of heavy metals subsurface contamination using *in situ* reactive zones. This work was in support of the Subsurface Contaminants Focus Area. Heavy metal contamination, including mercury is common at industrialized sites throughout the country. A number of DOE sites (e.g., RLO, INEEL, Pantex, Fernald, SRS) list soil metals as environmental problems in the context of remediation technology needs. Existing technologies typically involve excavation and off-site disposal. These technologies are costly, particularly when the contaminated area is large. Previous work on the removal of mercury from industrially contaminated soils has been conducted by the IETU. In those studies, ten pilot plots were established on a site located at the Tarnw Chemical Plant in Poland in order to evaluate the soil remediation of mercury and arsenic. These experimental sites are located in the vicinity of a chlorine production facility, mercury regeneration facility/combustion site and a vinyl chloride production facility.

A firm in Poland has developed a technology for precipitating the ionic forms of mercury in the subsurface using an *in situ* reactive zone technology. The precipitation of dissolved ionic mercury can be achieved via the fixation process by implementing this *in situ* reactive zone technology. This technology shows promise for reducing the risks posed by certain forms of mercury contamination and is ready for field-testing. Preliminary discussions with the technology developer indicated that the Tarnw site in southern Poland was suitable for field testing this technology. Site characterization studies were conducted to determine whether or not this site was appropriate for field testing of this technology. Specific project goals were established to form a working relationship between Florida State University, the Polish firm and the IETU and to review the technology and evaluate its potential applicability at the Tarnw site. Preliminary characterization data were collected as appropriate to address data gaps, and initial evaluation studies were conducted.

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Major Project Accomplishments

The Polish JCCES cooperation between the U.S. Department of Energy, Florida State University and the Institute for Ecology of Industrial Areas, Katowice, Poland has resulted in a number of international "firsts" and achievements.

The largest known deployments of phytoremediation as a technology to remove the heavy metal lead from soil were conducted in southern Poland as part of this effort. Those efforts have resulted in the documentation of phytoextraction cost and performance at field scale. In addition, efforts to minimize major cost factors have resulted in the development of specialized technologies to control the timing and location of soil and plant amendments.

Presentations at Key Conferences, Symposia & Workshops

Florida DEP Compliance & Enforcement Workshop, August, 1997, Tallahassee, Florida; "Environmental Contamination in Central and Eastern Europe - A Florida Perspective"

Florida Remediation Conference, Orlando, FL, November, 1997; "Application of Bioremediation to Contaminated Soils in Poland"

DOE EM briefing, July, 1998, Germantown, MD; "Poland Initiative - update"

SCFA Year-end Review October, 1998, Augusta, GA; "International Integration (presentation with SRTC EBS group)"

DOE EM briefing, November 1998, Germantown, MD; "International technology identification, development and demonstration"

Applied research, development & deployment cleanup and technology colloquium, May 1999, Scottsdale, AZ; "Phytoremediation - An effective technology to remove a variety of contaminants from soil"

SCFA Mid Year Review March, 2000, Albuquerque, NM; "The Poland Initiative"

Environmental Restoration Technology End User Conference, June, 2000 Charleston, SC; "Phytoremediation Research in Central & Eastern Europe"

SCFA Monthly Briefing, October, 2000, Aiken, SC; "International Projects - Status and Benefits to Savannah River Site"

Industry Partnerships for Environmental Science and Technology Conferences, October, 1998, 1999, 2000, Morgantown, WV; "Florida State University Research Activities Update"

Technology Information Exchange Workshop, November, 2000, Augusta, GA "Using Phytoremediation to Address the Challenge of Metals and Radionuclides in Subsurface Soils"

Kvantumelektronika '97, Budapest. P. Richter, A. Barócsi, L. Kocsányi, Zs. Csintalan, 1997; "Portable Chlorophyll Fluorometer"

Third International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe. P. Richter, I. Péczeli, Sz. Böröcz, L. Claudot, M. J. Kuperberg, 1997, September 10-13, Warsaw; "Field Measurement of the Distribution of Fuel Type Contamination in Soil by Fluorescence",

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Fourth International Symposium on Environmental Contamination in Central and Eastern Europe. P. Richter, A. Barócsi, Z. Csintalan, M. Kuperberg, J. Szdzuj, 1998, Warsaw; "Field Monitoring Soil Phytoremediation Technology by a Portable Chlorophyll Fluorometer"

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Fifth International Symposium on Environmental Contamination in Central and Eastern Europe (Prague 2000). P. Richter, A. Barócsi, Z. Csintalan, L. Kocsanyi, "Optimization of Conditions of Phytoremediation Using a Multipurpose Field Portable Chlorophyll Fluorometer", September 12-14, 2000.

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Success Stories

Applications for Chlorophyl Fluorometer at Savannah River Site Phytoremediation Projects: A device developed by Central European Advanced Technologies (CEAT), Budapest, Hungary will be deployed at SRS during FY01. Scientists from CEAT will deploy a chlorophyl fluorometer at the Savannah River Site during FY01. The purpose of this deployment will be to provide process monitoring information to Savannah River Technology Center personnel as they evaluate the potential for phytoremediation in several applications with the SRS. There is no other technology currently available that provides this type of information.

Applications for PCS Bioreactor at Savannah River Site: A petroleum contaminated soils (PCS) bioreactor has been developed cooperatively by the Savannah River Technology Center and the Institute for Ecology of Industrial Areas (IETU), Katowice, Poland. This bioreactor will be used to treat soils contaminated with a combination of low-level radiation and petroleum hydrocarbons. Soils contaminated with both radionuclides and petroleum currently are stored in radiation vaults at SRS. These vaults are expensive, have limited space, and do not provide a final disposal pathway for these soils. Off-site disposal options are limited due to regulatory restrictions for radiological wastes. Removal of the petroleum fraction of this contamination would enable cost-effective, permanent disposal of the treated soil on site as low-level radiological waste. The SRS PCS bioreactor is expected to begin operation in FY01.

Application of Phytoextraction to Contaminated Soils at Savannah River Site: Lead contamination in soils is a widespread problem of growing concern in the US and worldwide. Scientists at the Institute for Ecology of Industrial Areas

(IETU), Katowice, Poland working in cooperation with Florida State University and the U.S. Department of Energy have conducted field-scale scale evaluation of the cost and performance of phytoextraction as a technology for removing lead from large areas of contaminated soil. As a result, plans are underway to deploy this technology at a U.S. Department of Energy site. Plans call for the remediation of a section of berm from a small arms firing range within the Savannah River Site. This berm is representative of numerous firing ranges within the DOE complex (as well as at many other federal installations). The soils associated with firing ranges become contaminated with lead from the fragmentation of bullets fired during training activities. The baseline technology for firing range remediation is excavation, sieving to remove large fragments and off-site disposal of residual contaminated soils. Phytoextraction is a promising technology for the remediation of this residual soil.

Other Major Accomplishments (e.g., development of instrumentation, like the chlorophyll fluorometer): The deployment of the CEAT chlorophyll fuorometer is the first application of this technology for process monitoring of plant-based remedial technologies. While the physiological processes associated with plant stress and chlorophyll fluorescence (Kautsky kinetics) are well known, their application to environmental remediation is novel. The instrument developed by the CEAT is specially designed to be field portable, user friendly and capable of collecting and storing data for multiple days of sample collection without the need for battery charges or data downloads.

V. PLANNING AND EXECUTION OF DOE INTERNATIONAL SYMPOSIA AND CONFERENCES

Background

The IICER at Florida State University has utilized a variety of mechanisms for accomplishing its primary goals of environmental technology identification and evaluation, including organizing international meetings. The Florida State University has an extensive history of conducting DOE-sponsored international conferences, symposia (and associated exhibitions) and workshops in order to accomplish a number of the objectives related to cooperative agreement DE-FC21-EW55101. These objectives included the following:

- exchange technical information on environmental problems and technological solutions for these problems;

- form research and technology deployment linkages for conducting joint activities among international partners;

- identify unique and innovative environmental technologies for application at sites within the DOE complex which are less costly and/or more rapidly effective than technologies currently available to U.S. stakeholders; and

- facilitate development and application/deployment of innovative and/or low-cost environmental technologies.

These objectives have been accomplished since 1995 through a number of large international events conducted by the IICER including, the on-going series of symposia on environmental contamination in Central and Eastern Europe (Warsaw '96, Warsaw '98, Prague 2000), the International Symposium and Trade Fair on the Clean-up of Manufactured Gas Plants - MGP '95 (Prague, Czech Republic, September of 1995) and the 1997 International Containment Technology Conference and Exhibition (St. Petersburg, Florida, February of 1997).

These DOE-EM-sponsored events have not only been successful in attaining these objectives, but also have been successful in bringing international recognition and attention to the activities of both DOE/OST as well as the Florida State University. This success and recognition is important not only in terms of accomplishment but also in terms of attracting high quality participants worldwide to subsequent activities sponsored by DOE/OST and the Florida State University.

As one example, on 12-14 September 2000, the Fifth International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe (Prague 2000) was conducted. This event was patterned after the four previous successful symposia in the series. The focus of the Prague 2000 Symposium was on technology deployment in the context of the needs of DOE/OST. This symposium was conducted in Prague, Czech Republic. Approximately 800 participants from all over the world participated at the symposium. The results of the symposium will be disseminated in a published proceeding (CD-ROM format). The DOE, EPA, DOC, NATO and other international organizations sponsored this event.

From 1995-2000, the Florida State University, in conjunction with DOE, organized and conducted international conferences, symposia and related exhibitions. All technical and logistical aspects of organizing and executing these events were conducted by the Florida State University, including the preparation of all announcements, programs; identification and management of facilities for the sessions, exhibition, posters, receptions and workshops; conducting the on-site registration; reserving and managing participants accommodations; arranging for audio-visual and related needs at the symposium; and other critical aspects of planning for and conducting these large international events.

Project Publications

(See publications for each major event)

Major Project Accomplishments

International Containment Technology Workshop

29-31 August 1995, Baltimore, Maryland, USA; Omni Inner Harbor Hotel; 100 participants. Purpose: This workshop addressed the gap between what was known and understood about environmental containment technologies and the level of information needed to support consistent decision-making relative to their application in remediation. This was accomplished by convening a large group of experts from academia, industry, and government agencies in the U.S. and abroad to conduct a careful review and discussion of the applicability and reliability of these technologies and to identify information, research, and development needs. Publication: "Assessment of Barrier Containment Technologies: A Comprehensive Treatment for Environmental Remediation Applications", edited by Ralph R. Rumer and James K. Mitchell, Published by Florida State University (437 pages).

Follow-up International Containment Technology Workshop
8-9 November 1995, Dover, Delaware, USA; Dover Air Force Base; 50 participants. Purpose: This follow-on meeting presented the results of the Baltimore Workshop prior to completion of the final project publication which serves as a reference document for containment technologies. Principal invitees were other DOE, EPA, and DOD agency staff. Publication: "Assessment of Barrier Containment Technologies: A Comprehensive Treatment for Environmental Remediation Applications", edited by Ralph R. Rumer and James K. Mitchell, Published by Florida State University (437 pages).

Third International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe (Warsaw '96)
10-13 September 1996, Warsaw, Poland; 550 participants; Warsaw Marriott Hotel. Purpose: This symposium evaluated solutions to problems related to subsurface contaminants, including solvents, radioactive and mixed waste and contaminated air, water and land as well as identified successful applications of both innovative and low-cost environmental technologies. A major emphasis of the symposium was on identifying and assessing technology transfer and exchange opportunities. Publication: Proceedings of the Third International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe (1,018 pages).

1997 International Containment Technology Conference and Exhibition
9-13 February 1997, St. Petersburg, Florida, USA; 600 participants; Trade Winds Hotel. Purpose: This conference addressed issues related to state-of-the-art and innovative technologies for containment systems designed for contaminated sites. The technical areas addressed during this conference focused on the worldwide application of containment and related barrier or control technology systems at existing contaminated sites, as well as the design and construction of containment systems form newly-constructed facilities. Several ancillary events included two training seminars and a site tour of a U.S. Department of Energy facility where environmental technologies were being applied. Publication: Proceedings of the 1997 International Containment Technology Conference and Exhibition (1,040 pages).

Fourth International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe (Warsaw '98)
15-17 September 1998, Warsaw, Poland; 550 participants; Warsaw Marriott Hotel. Purpose: This symposium evaluated solutions to problems related to subsurface contaminants, including solvents, radioactive and mixed waste and contaminated air, water and land as well as identified successful applications of both innovative and low-cost environmental technologies. A major emphasis of the symposium was on identifying and assessing technology transfer and exchange opportunities. Publication: Proceedings of the Fourth International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe (CD-ROM).

Interagency Dense Non-Aqueous Phase Liquid (DNAPL) Consortium Memorandum of Agreement Signing Ceremony
6 April 1999 Cape Canaveral Air Station, Florida, USA; 150 participants; National Aeronautics and Space Administration (NASA), John F. Kennedy Space Center, Launch Complex 34. Purpose: This Interagency Dense Non Aqueous Phase Liquid (DNAPL) Consortium joined efforts and formalized a Memorandum of Agreement (MOA) to demonstrate DNAPL characterization and remediation technologies and monitoring systems. The Consortium members include: U.S. Department of Energy, Office of Science and Technology (DOE-OST); U.S. Air Force Research Laboratory, Air Base and Environmental Technology Division (since the signing of the MOA, the Navy has replaced participation of the Air Force); U.S. Environmental Protection Agency, National Risk Management Research Laboratory (EPA-NRMRL); National Aeronautics and Space Administration, Kennedy Space Center (NASA-KSC); and U.S. Air Force 45th Space Wing (45th Space Wing). These agencies have combined resources and formed the Interagency DNAPL Consortium to demonstrate innovative remediation and characterization technologies. The interagency agreement supports the testing of new and existing technologies in side-by-side demonstrations to compare cost and performance data that will be used to expedite regulatory acceptance and use of these innovative remedial technologies at other sites. The effort to share expertise among federal agencies in side-by-side comparisons will provide valuable performance and cost data. The anticipated result will be more effective DNAPL treatment systems that operate at a lower overall cost. Publication: IDC Memorandum of Agreement

DNAPL Consortium Visitor's Day
25-26 January 2000, Cape Canaveral, Florida, USA; National Aeronautics and Space Administration (NASA), John F. Kennedy Space Center; 260 participants.
Purpose: This Visitor's Day introduced three innovative "side-by-side" technology demonstrations being conducted at Launch Complex 34 (LC-34) at NASA Kennedy Space Center, Florida to federal and state end users, technology developers, contractors and interested parties. Three test cells were set up at the Engineering Support Building at LC-34 to evaluate and compare the cost and performance of *in situ* thermal and oxidation DNAPL remediation technologies through concurrent testing under realistic, field-scale conditions. The Visitor's

Day event brought 260 state, federal and press representatives to view first hand the work being conducted for this project. Publication: None

Technical Information Exchange (TIE) Workshop: Session entitled DNAPL Overview

26 October 1999, Las Vegas, Nevada, USA; New Orleans Hotel; 100 participants. Purpose: Florida State University organized this session which included presentations from several U.S. Federal Agencies and the Ontario Canadian Provincial Government on current research and development areas concerning DNAPL contamination. The purpose of this session of the TIE workshop was to have a panel develop a strategy and plan to acquire data and related information that could be used to help remediate sites in increasingly complex geologic and hydrologic conditions. In addition, the purpose of the session was to determine research needs and begin discussion on how to avoid redundant funding of these needs. The session continued on with discussions that originated as a result of the Cape Canaveral Interagency DNAPL Consortium IDC project which is the model consortium arrangement that is to be used for future projects in terms of organizational structure and cooperation. Florida State University coordinated the presentations and logistics of the session as well as assisted at the workshop. Publication: Abstracts submitted to TIE Quarterly Publication.

Fifth International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe (Prague 2000)

12-14 September 2000, Prague, Czech Republic; Prague Marriott Hotel*;* 800 participants. Purpose: This symposium evaluated solutions to problems related to subsurface contaminants, including solvents, radioactive and mixed waste and contaminated air, water and land as well as identified successful applications of both innovative and low-cost environmental technologies. A major emphasis of the symposium was on identifying and assessing technology transfer and exchange opportunities. In addition to the 800 participants from over 40 countries, the symposium also conducted a Student Scholars and Symposium Fellows program, involving over 200 graduate students and "young" environmental professionals. Also an exhibition was conducted concurrently with the symposium technical sessions. Publication: Proceedings of the Fifth International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe (CD-ROM).

VI. NATO/CCMS Pilot Study on Evaluation of Demonstrated and Emerging Technologies for the Treatment and Clean-up of Contaminated Land and Groundwater (Phase III) Annual Meetings/DOE Headquarters Participation

Thre following are the annual Pilot Study Meetings organized by Florida State University and which were attended by DOE personnel:

- 2000 Annual Pilot Study Meeting - Wiesbaden, Germany

- 1999 Annual Pilot Study Meeting - Angers, France
- 1998 Annual Pilot Study Meeting - Vienna, Austria
- 1997 Annual Pilot Study Meeting - Golden, Colorado, USA
- 1996 Annual Pilot Study Meeting - Berlin, Germany

Purpose: CCMS stands for Committee on Challenges of Modern Society - this program is within the Scientific Affairs Division of NATO and it focuses principally on non-defense related issues (e.g., the environment). Building a knowledge base so that innovative and emerging technologies are identified and evaluated is the impetus for this NATO/CCMS Pilot Study which has been in existence since 1985. Under this current study (Phase III), new technologies being developed, demonstrated, and evaluated in the field are discussed. This allows each of the participating countries (Including DOE) to have access to an inventory of applications of individual technologies which allows each country to target scarce internal resources at unmet needs for technology development. The technologies include biological, chemical, physical, containment, solidification/stabilization, and thermal technologies for both soil and groundwater. This current pilot study draws from an extremely broad representation of international participants who chiefly represent agency or ministry environmental technology development programs. For this Pilot Study, DOE and EPA provide agency representatives for the annual meetings and to represent the United States at these NATO/CCMS sanctioned meetings. Florida State University organizes these annual meetings for DOE and EPA. Publications: NATO/CCMS Pilot Study Annual Reports: 1985-2000 (CD-ROM) (Published courtesy of the U.S. EPA's Technology Innovation Office (EPA542-C-99-002).

VII. TECHNOLOGY INTEGRATION ACTIVITIES: RUSSIA AND CENTRAL & EASTERN EUROPE

Background

A major focus of the IICER's work for DOE under this cooperative agreement was on the Central and Eastern European region and Russia. The motivation for focusing on this region of the world involves the technical and scientific capabilities that are available throughout Central and Eastern Europe and Russia. The educational and technical skill levels of scientists in these countries is world class. Plus, many scientists, particularly nuclear physicists and nuclear chemists, have been working on problems similar to those within the DOE Complex for many decades. The opportunities to find scientific personnel, technologies and facilities that could be used to help DOE solve its problems are abundant. As a result, an important aspect of the work for this cooperative

agreement was focused on working with environmental scientists from these countries on DOE-related research and technology development projects.

In order to accomplish this work it was necessary to use specialists who are familiar with:

- the needs of DOE field personnel;

- environmental scientists and research institutes in Central and Eastern Europe and Russia; and

- environmental and embassy personnel in Hungary, Czech Republic, Poland, Russia (and the other countries in this region of the world) as well as in the key agencies in Washington, DC.

Through this task, these specialists have provided critical assistance to the many projects for this five-year cooperative agreement. The use of these technology integration specialists has also proven to be both efficient and effective in terms of administering the projects involving Russia and Central and Eastern Europe. The objective of this task was to assist Florida State University and DOE with the coordination of the technology integration activities associated with Russia and Central and Eastern Europe.

The IICER provided for these needs and retained technology integration specialists under contract (SAIC sub-contract) for this cooperative agreement. These SAIC professionals were responsible to the IICER who provided oversight of these individuals and directed their activities involving the technology integration activities for this cooperative agreement as they pertain to the Central and Eastern European region and Russia.

(For details on accomplishments, success stories, etc. for this task, see section IV. of this report.)

VIII. TECHNOLOGY INTEGRATION ACTIVITIES: ARGENTINA

Background

In 1996, DOE's Office of Science and Technology established a cooperative program with the National Atomic Energy Commission of the Argentine Republic to conduct joint research and technology development projects related to nuclear waste management. Initial technical areas of mutual cooperation for this program were the following:

- Uranium mill tailings remediation;

- Decontamination and decommissioning; and

- Research and development involving low- and high-level wastes.

Of importance to Florida State University and DOE-EM, are the use of technology integration specialists who are familiar with the needs and personnel of DOE and the capabilities within Argentina related to nuclear waste management. Through this task, these specialists have provided critical assistance to the joint DOE/Argentine projects. The use of these technology integration specialists has proven to be both efficient and effective in terms of administering these projects involving Argentina. The objective of this task was to assist with the coordination of the technology integration activities associated with the DOE/Argentine JCCRM Program.

The IICER retained specialists under contract (SAIC sub-contract) who are capable of assisting with the issues pertaining to the technology integration activities associated with the DOE/Argentine JCCRM Program for this cooperative agreement. These specialists were responsible to the IICER who will provided oversight of these individuals and directed their activities involving the technology integration activities for this cooperative agreement as they pertain to implementation of the DOE/Argentine JCCRM Program.

(For details on accomplishments, success stories, etc. for this task, see section III. of this report.)

IX. HIGH-LEVEL WASTE (HLW) RETRIEVAL, TREATMENT AND DISPOSAL, SAFE HANDLING AND TREATMENT OF NUCLEAR MATERIAL, SUBSURFACE/VADOSE ZONE PROGRAM PLANNING & STRATEGIC PLANNING OF ENVIRONMENTAL SCIENCE AND TECHNOLOGY REQUIREMENTS FOR DOE

Background

This multi-faceted task addressed the evaluation of DOE-EM technologies for safe retrieval, treatment, and disposal of HLW stored at DOE sites. This task also included an evaluation of alternatives for technical solutions that will provided back-up for privatized HLW activities at Hanford and other DOE sites. In addition, this task included an evaluation of the environmental health and safety components of the various alternatives that were identified. Cooperative work with EM-30, the Tanks Focus Area, and the principal DOE HLW sites were conducted. The objectives of this task included the following:

- To evaluate EM/OST technologies for safe retrieval, treatment, and disposal of HLW stored at DOE sites.

- To evaluate alternatives for technical solutions that will provide back up for privatized HLW activities at Hanford and other DOE sites.

The work for this task also included extensive and appropriate interactions with the DOE Tanks Advisory Panel or TAP which was conducted by Dr. Donald Oakley of Florida State University.

The work for this task included the evaluation of technologies for the safe storage, treatment, handling, and disposition of nuclear materials, principally plutonium and uranium, currently being managed by DOE-EM. This work for this task also included participation on site-specific technical review panels to evaluate options for stabilizing, storage, and shipment of nuclear materials. A security clearance was required for certain activities under this task. The objective of this task was to evaluate technologies for the safe storage, treatment, handling, and disposition of nuclear materials, principally plutonium and uranium.

DOE's Office of Science and Technology, in an attempt to respond to concern about contaminant migration uncertainties at the Hanford Site and other DOE sites with extensive and/or complex subsurface conditions, embarked on extensive planning exercises to develop a program for addressing subsurface and vadose issues. Florida State University contributed to these planning efforts by having John Koutsandreas serving on the Book Project Steering Committee for the publication: Vadose Zone: Science and Technology Solutions. In addition Dr. Donald Oakley provided technical input to these planning exercises.

The work for this task required participation in the strategic planning of EM/OST activities. Emphasis was placed on contributions to “roadmapping” activities, peer reviews of ongoing programs, and evaluation of external advisory committee recommendations (e.g., EMAB, LOB, GAO, NAS, others). The integration of science program results with technology applications was a major aspect of this task. The objectives of this task were the following:

- To support strategic planning of EM/OST activities, with an emphasis on contributions to “roadmapping” activities, peer reviews of ongoing programs, and evaluation of external advisory committee recommendations.

- To integrate OST science program results with technology applications at DOE sites.

Publications

Oakley, D., Boyd, G., 2000, Worker Safety and Health Improvement through the Deployment of Environmental Cleanup Technologies, Proceedings of the Fifth International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe, Prague 2000, September 12-14, 2000.

Oakley, D., 2000, Radiation Protection Aspects of Nuclear Waste Separations, Proceedings of the Fifth International Symposium and Exhibition on

Environmental Contamination in Central and Eastern Europe, Prague 2000, September 12-14, 2000.

Boyd, G., Scott, R., Oakley, D., Science and Technology Contributions to Improving Worker Safety and Health, Waste Management 2001, to be published in the Proceedings, May 2001.

Major Project Accomplishments

Dr. Oakley has supported the DOE Office of Science and Technology, Office of Environmental Management in the assessment of HLW safety issues, evaluation of new technologies, worker safety and health, and the development of new planning tools, e.g. roadmaps for long-term R&D requirements. He has participated in the support and development of programs for emerging cleanup issues, such as vadose zone remediation, R&D for long term stewardship, and disposition of depleted uranium.

Supported the DOE HLW Tanks Advisory Panel (TAP), with emphasis on ensuring the safety of storage, retrieval and processing of HLW at Hanford. Served as a member of Tank SY-101 TAP Remediation Panel, which provided the DOE with justification for resolving the 9 year-old limitation on the use and monitoring of the tank. A report was provided to the Office of River Protection in October 2000. This effort required almost 2 years of meetings with DOE and contractor staff to resolve safety issues related to removing the contents of the tank and allowing the tank to remain in service.

Additional on-going support was provided for worker safety and health aspects of HLW tank storage and retrieval operations. A Worker Safety and Health SubTAP has meets quarterly at Hanford to review issues of worker exposure, emergency planning, and safe work planning procedures at the site. Following each meeting a report is prepared and submitted to the DOE.

Participated in development of new programs and resolution of technology issues. Supported a survey of alternative technologies to be considered for the treatment of HLW at the Hanford Site. Reviewed alternatives to the treatment of HLW at the Savannah River Site. Supported the development of a vadose zone remediation strategy for DOE sites. Evaluated remediation strategies for depleted uranium and related environmental issues. Reviewed numerous external reviews of the Office of Science and Technology (NAS, GAO, peer reviews) and suggested various options for addressing issues. Participated in evaluation of new HLW melter alternatives and the use of foreign melter technologies.

Provided support and leadership for the incorporation of worker safety and health features in to the development and deployment of new remediaton technologies. This required working with technology developers, workers, and unions to reach a common ground. Under the new working relationship, workers have an active voice in assessing safety of new technologies before actual deployment. This

activity has supported the Assistant Secretary's (Environmental Management) highest-priority operating principle – to conduct work safely.

Presentations at Key Conferences

Oakley, D., Boyd, G., 2000, Worker Safety and Health Improvement through the Deployment of Environmental Cleanup Technologies, Proceedings of the Fifth International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe, Prague 2000, September 12-14, 2000.

Oakley, D., 2000, Radiation Protection Aspects of Nuclear Waste Separations, Proceedings of the Fifth International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe, Prague 2000, September 12-14, 2000.

Boyd, G., Scott, R., Oakley, D., Science and Technology Contributions to Improving Worker Safety and Health, Waste Management 2001, February, 2001, to be published in the Proceedings, May 2001.

Success Stories

Provided major contribution to the resolution of safety issues at Hanford's Tank SY-101. This was the highest priority of the Washington State Department of Ecology during most of the 1990's, and one of the highest priorities of DOE. Successful closing of the safety issue was covered in the national press, including the New York Times and AP.

Contributed to the re-evaluation of technologies and development of new technologies for the removal of Cs-137 from SRS HLW. This work will probably lead to a multi-hundred millions of dollars in cost savings after a technology is selected in the summer of 2001.

Provided support and training for the incorporation of safety and health features in to new technologies. This effort has been widely recognized by workers and regulatory groups as an important feature of newly-deployed technologies.

X. HIGH PRESSURE JET GROUTING CONTAINMENT TECHNOLOGY DEMONSTRATION PROJECT

Background

In 1996-1997, Florida State University assisted DOE-EM with the implementation of demonstration of an Italian high-pressure jet grouting technology at the Groundwater Remediation Field Laboratory National Test Site (GRFL) at Dover AFB in Dover, Delaware. This project was implemented through the National Environmental Technology Test Sites (NETTS) Program and a program co-sponsored by the DOE-OST, U.S. Air Force and DuPont Company. The objectives of this field study were to further understand and document the use of

high-pressure jetting for emplacement of thin diaphragm walls for hydraulic control in environmental applications and to test verification and monitoring techniques to validate the emplaced subsurface barrier.

High-Pressure jet grouting has been used for decades to create columnar-type pillars to underpin foundations, but only recently has the use of these thin-walled structures been considered for environmental subsurface containment. These thin-walled structures are created by jetting cement-bentonite mixtures at approximately 90 gpm at 5,800 psig in two opposing directions. The resultant thin diaphragm walls are emplaced to act as a barrier with the grouting materials having a lower hydraulic conductivity than the surround natural materials. The diaphragm walls can be used as part of a containment strategy to:

- Control contaminated groundwater flow;
- Divert groundwater flow; or
- Emplace materials for treatment (e.g., reactive walls).

This project resulted in the construction of multiple deep boxes that were used to validate the hydraulic parameters of these emplaced subsurface barriers. Using a variety of tests (e.g., dissipation tests pneumatic tests, vacuum tests and dye tracer tests these boxes were evaluated for their hydraulic integrity and mechanical strength. In addition, a variety of verification and monitoring techniques were evaluated as part of the project.

Florida State University participated in the overall project management through sub-contractor management.

Project Publications

Cement Bentonite Thin Diaphragm Wall Jet-Grouting Demonstration Project, Final Project Report (DOE Contract No.: AC22-96EW96405), Dover Delaware, Septemeber 1998.

Major Project Accomplishments

Based on the Constructive Quality Assurance (CQA) inspections performed during Phase I emplacement of test panels and small barrier boxes, all of the quality criteria specified were satisfactorily met with the following exceptions:

- Jet orientation at completion of grouting for nine panels was out of alignment beyond the specified criteria and
- Grout rod verticality (at full panel depth) exceeded the specified criteria in 50% of the small barrier box panels.

Based on the results of Phase I, it was decided to go forward with the Phase II planned work. The objective of Phase II was to build, verify and monitor a double-walled coffer dam to determine if it was constructed as planned and that it met the emplacement criteria in the Phase II Work Plan. The Phase II barrier containment was constructed, though not as originally planned. Because of unanticipated subsurface characteristics, the emplacement project organizers elected to build two separate coffer dams that were not concentric, which did not result in the double walled dam, but rather two single walled, side-by-side dams.

The Phase I and Phase II containment barriers were constructed, though not as originally planned. Overall the success of this project was significant in that it demonstrated that environmental containment barriers can be built using this thin-walled technology, although emplacement technology gaps remain to be addressed.

Substantial advancements were also made in the area of verification technologies for subsurface barriers. These technological advancements support progress for all subsurface barriers, not just the thin-walled technology.

XI. INTERAGENCY DNAPL CONSORTIUM - SIDE BY SIDE COMPARATIVE TECHNOLOGY DEMONSTRATIONS FOR DNAPL SORCE ZONE REMEDIATION

Background

The U.S. Department of Energy, Office of Science and Technology (DOE-OST); U.S. Air Force Research Laboratory, Air Base and Environmental Technology Division (AFRL/MLQ); U.S. Environmental Protection Agency, National Risk Management Research Laboratory (EPA-NRMRL); National Aeronautics and Space Administration, Kennedy Space Center (NASA-KSC); and the U.S. Air Force 45th Space Wing (45th Space Wing) combined resources to implement this project by forming the Interagency Dense Non Aqueous Phase Liquids (DNAPL) Consortium (IDC). The IDC conducted side-by-side demonstrations of DNAPL remediation and monitoring technologies at this KSC site. The objective of the demonstrations was to evaluate and compare the cost and performance of *in situ* thermal, flushing and oxidation DNAPL remediation processes through concurrent testing under realistic, field-scale conditions and in similar geologic conditions. Technical reports documenting the costs and performance were published so that informed decisions can be made regarding the relative costs and performance capabilities of these DNAPL remediation technologies.

The demonstrations were conducted at Launch Complex 34 (LC34) at Cape Canaveral Air Station (CCAS), Florida. The pre-project technology evaluation was completed and designs evaluated and selected. During this project Florida State University's role was to maintain project management so that the project participants were properly coordinated to ensure that proper project coordination and management was maintained. Florida State University provided on-site field

project management for all of the activities conducted at the site. These activities included oversight of all site characterization activities performed at the site. Florida State University also conducted health and safety monitoring, and site surveying support to the project as necessary.

Florida State University's involvement also consisted of managing site logistics and fieldwork which will include day-to-day technical support consisting of proposal and data review, specification writing, managing team logistics, field project management, and reporting as directed by the Core Management Team (CMT) for the project.

The Interagency DNAPL Consortium (IDC) proposed to identify one or more cost-effective technologies capable of remediating DNAPL source areas in the saturated zone at the demonstration site to fully meet agreed upon site cleanup goals. On April 13, 1999, senior representatives of the IDC met at the John F. Kennedy Space Center to sign a Memorandum of Agreement MoA) regarding this joint, interagency project. Representatives from DOE, EPA, NASA and DOD (Department of the Air Force) signed this MoA to signify the importance of this project.

Although progress has been made in recent years to develop and improve DNAPL mass removal and *in situ* destruction technologies, there are no “silver bullets” - methods that by themselves are likely to be capable of complete site restoration - especially for DNAPLs in the saturated zone. The IDC believes that some of the relatively mature, innovative technologies now becoming available (e.g., surfactant or co-solvent flushing, chemical oxidation, and thermal methods) show great promise, but likely must be combined with other technologies (e.g., bioremediation) to form treatment systems to effect cleanup to acceptable levels.

Performance levels and objectives must be clearly identified prior to each demonstration. For example, possible performance criteria include the percent reduction in groundwater concentrations of TCE, the estimated total quantity of TCE treated and/or removed, indirect measurements of effectiveness such as byproduct concentrations, or the ability of the technology to achieve regulatory limits.

The objectives of this multi-year project included the following:

- To identify one or more cost effective technologies capable of remediating DNAPL source areas in the saturated zone at the demonstration site to fully meet agreed upon site clean up goals.

- To collect and evaluate cost and performance data on the technologies demonstrated.

- To provide information to the Subsurface Contaminants Focus Area for integration with DOE projects and needs related to source zone DNAPL remediation.

Major Project Accomplishments

Florida State University has successfully managed all fieldwork conducted at the Cape Canaveral in support of the Interagency DNAPL Consortium. Specifically, FSU assured that the characterization and remediation systems installations were successfully accomplished. The following activities were completed in cooperation with the IDC contractors:

- Source zone characterization for the location of the demonstrations;

- Pre demonstration characterization for the Six Phase Heating, Permanganate Oxidation and the Steam Stripping treatment cells for mass estimations;

- Design Review of the Six Phase Heating, Permanganate Oxidation and the Steam Stripping remediation systems final designs;

- Installation of the Six Phase Heating and Permanganate Oxidation technologies;

- Pre and post demonstration microbial sampling for the Six Phase Heating and Permanganate Oxidation technologies (Pre demonstration for the Steam Stripping); and

- Post demonstration characterization of the Six Phase Heating and Permanganate Oxidation technologies.

Presentations at Key Conferences, Symposia

Florida State University assisted with the planning of the technical open house held at Launch Complex 34 in 2000. Florida State University also participated in the site tour via presentations on the site characterization and technology deployments described above.

Florida State University assisted with the signing ceremony for the Interagency DNAPL consortium held at Launch Complex 34 in 1999.

Florida State University organized the following workshop on the characterization and remediation of DNAPL source zones during the Prague 2000 Symposium conducted on 12-14 September 2000 in Prague, Czech Republic:

"Interagency DNAPL Consortium - DNAPL source removal at Launch Complex 34, Cape Canaveral, FL: A field scale demonstration of three source removal technologies side-by-side"

Florida State University also presented at the NASA 2000 Environmental Conference:

"Interagency DNAPL Consortium - DNAPL source removal at Launch Complex 34, Cape Canaveral, FL: A field scale demonstration of three source removal technologies side-by-side"

Florida State University made a presentation at the Warsaw '98 Symposium and Exhibition which was conducted on 15-17 September 1998 in Warsaw, Poland entitled:

"Removal Of Heavy Metals From Soils Using Phytoremediation"

Success Stories

Florida State University assisted with the following site characterization and screening and DNAPL removal technology deployments at Cape Canaveral, FL, Launch Complex 34:

- Laser Induced Fluorescence (LIF)-for direct detection of DNAPL;
- Cone Sipper-for depth discrete water sampling;
- Cone Permeameter-collection of in situ hydraulic data;
- NAPL Ribbon Sampler-direct detection of NAPL in situ;
- Raman Spectroscopy-direct detection of NAPL;
- Six Phase Resistive Heating; and
- Permanganate Oxidation.

This project successfully engaged multiple U.S. federal agencies (i.e., DOE, EPA, Air Force, NASA) in efforts to address a shared environmental problem. This problem, involving dense non-aqueous phase liquids or DNAPLs is not only a major problem at U.S. federal facilities, but it is highly pervasive at industrial facility sites as well as state and local government sites. Beyond the U.S. domestic concerns with DNAPLs, this form of contamination is also widely present at sites throughout the developed world. Beyond the technical successes garnered through the side-by-side technology demonstrations, important success was achieved in the context of coordinating effectively with

multiple agencies in terms of technical, financial and management aspects of the project.

CONCLUSIONS

The work for this cooperative agreement involved a variety of activities, each designed to provide assistance to DOE in terms of its efforts to clean-up contaminated sites throughout the complex. As evidenced by the many accomplishments, success stories, publications, etc. described in this report, the work of this cooperative agreement was both successful and substantial in scope and application in the context of helping to attain DOE's environmental clean-up mission. The approach taken was to use a variety of mechanisms to attain the objectives of this cooperative agreement, including the following:

- technology identification, development, demonstration, validation and deployment;
- technology integration and technical assistance;
- cooperative environmental technology demonstration/validation in support of the OST Focus Areas;
- data collection, synthesis, evaluation;
- international conferences, symposia and workshops; and
- professional/scientific exchanges of personnel.

To this end, it is concluded that these activities were highly successful in attaining the following planned objectives:

- To ensure that research and development projects were strategically focused on solving near-term clean-up problems within the DOE complex.
- To focus on technology development and deployment efforts that resulted in "widely deployable" technologies (i.e., OST Focus Area developed technologies that could be successfully deployed for multiple applications throughout the DOE complex).
- To work to ensure close coordination among EM headquarters, DOE-EM technology developers, field offices, contractor officials and end-user organizations within the DOE complex to be sure that technology "tools" were delivered to address specific DOE clean-up problems.
- To adhere closely to the structure of the technology development "gates system" which ensures that "user needs" and "user performance

requirements" were closely reflected in subsequent technology development and deployment initiatives.

- To ensure "early" end-user integration in OST Focus Area technology development and deployment planning and implementation.