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U.S.- FORMER SOVIET UNION

ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT ACTIVITIES

MARCH 1994

A U.S. DEPARTMENT OF ENERGY COOPERATION
PROGRAM WITH THE FORMER SOVIET UNION

MASTER

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Introduction

The Office of Environmental Management (EM) has been delegated the responsibility for the Department of Energy's (DOE) cleanup of the nuclear weapons complex. The nature and magnitude of the waste management and environmental remediation problem requires the identification of technologies and scientific expertise from domestic and foreign sources.

Operational DOE facilities, as well as the decontamination and decommissioning of inactive facilities, have produced significant amounts of radioactive, hazardous, and mixed wastes. In order to ensure worker safety and the protection of the public, DOE must 1) assess, remediate, and monitor sites and facilities; 2) store, treat, and dispose of wastes from past and current operations; and 3) develop and implement innovative technologies for environmental restoration and waste management.

Example:

At the Hanford Site there are 177 metal tanks containing waste generated from plutonium separation processes. These tanks hold 410,000 metric tons of stored waste which must be deactivated, decontaminated, decommissioned, and dismantled. DOE has made progress toward the resolution of safety issues associated with high-level waste storage, but uncertainties remain regarding new tank construction and design.

The investment made by the United States (U.S.) in environmental restoration and waste management activities must be double-edged. Taxpayer dollars are spent on site cleanup, but they must also assist in the strengthening of the national economy, particularly the environmental industry. A stronger domestic environmental industry will improve U.S. competitiveness in international markets and enhance domestic technology development and application.

The EM directive necessitates looking beyond domestic capabilities to technological solutions outside the boundaries of the U.S. EM's interactions with the former Soviet Union (FSU) clearly illustrate this opportunity. The recent collapse of the Soviet government has made formerly restricted elite Soviet scientific expertise available to the West. EM has established a cooperative technology

development program with FSU scientific institutes that meets domestic cleanup objectives by: 1) identifying and accessing FSU EM-related technologies, leveraging investments and providing cost-savings; 2) improving access to technical information, scientific expertise, and technologies applicable to EM needs; and 3) increasing U.S. private sector opportunities in the FSU in EM-related areas.

EM Mission

The EM mission is to: 1) treat, store, and dispose of hazardous, radioactive, and mixed waste in an environmentally sound and effective manner; 2) bring all DOE facilities and sites into compliance and operate them in accordance with applicable laws and regulations aimed at protecting public health and the environment; and 3) develop and implement innovative, cost-effective technologies to facilitate compliance with applicable laws, regulations, and agreements and to minimize the generation of waste. EM supports DOE's production and research goals through its waste management and compliance activities and is also responsible for decontamination and decommissioning of surplus facilities. EM works to ensure that potential risks to human health and safety and to the environment, posed by the Department's past, present, and future operations, will be either eliminated or reduced to prescribed, safe levels through cleanup of the existing inventory of inactive sites and facilities by 2019.

"Environmental restoration is becoming a serious concern in Russia and we want to cooperate to the extent that we can in solving mutual problems."

Hazel O'Leary
Secretary of
Energy

Memorandum Of Cooperation and the Joint Coordinating Committee for Environmental Restoration and Waste Management

The Peaceful Uses of Atomic Energy (PUAE) Agreement was signed between DOE and the Ministry of Atomic Energy for the Russian Federation (MINATOM) and provides a mechanism for cooperation in research, development, and safe utilization of nuclear energy, with the primary objective being to develop new, safe, and environmentally sound energy sources. Under the umbrella of the PUAE Agreement, DOE and the former Ministry of Atomic Power and Industry signed a Memorandum of Cooperation (MOC) in the areas of Environmental Restoration and Waste Management in September 1990. The MOC provides the mechanism for conducting joint technology development activities in the areas of environmental restoration and waste management. Both DOE and the FSU have been engaged in aggressive technology development programs over the past

several decades. Following the breakup of the USSR, MINATOM assumed responsibility for activities conducted with Russia under the auspices of the MOC.

The current MOC identifies five areas for cooperation: (1) development of policy and practices regarding environmental restoration and waste management; (2) evaluation of problems related to environmental remediation, decontamination and decommissioning of facilities and materials contaminated by radioactive and other hazardous waste; (3) research and development directed at improving the effectiveness, economics, safety and public acceptability of methods of handling, storing and permanently disposing of radioactive and associated hazardous waste; (4) analyses and investigations related to waste partitioning to facilitate permanent disposal; and (5) analyses and investigations related to geologic disposal of radioactive wastes.

The Joint Coordinating Committee for Environmental Restoration and Waste Management (JCCEM) was established as the managing body for the MOC. JCCEM responsibilities include: review of progress and plans for activities conducted under the MOC; approval of JCCEM actions and proposals; coordination and approval of future cooperative activities with respect to technical merit and level of effort; improved access to technical information and commercial opportunities in Russia; support of the selection of cost-saving technologies; and ensured continued dialogue and cooperation in EM related areas.

The 1st JCCEM meeting was held in Russia in November 1990. A detailed plan was developed for the implementation of a series of technical exchange workshops in three areas: vitrification, separations, and contaminant transport. A provision for the exchange of students and senior scientists was provided for in the implementation plan. Initial efforts were focused on identifying available

Implementation structure for DOE/FSU programs.

FY '93 Technical Focus

- Areas of cooperation
 - Vitrification
 - Separations
 - Contaminant transport
 - Radiochemical processing safety
 - Geologic Repositories
 - Scientist exchanges

technologies and increasing understanding of FSU government structure roles and responsibilities.

The 2nd JCCEM meeting was held in Moscow in November 1992. It resulted in contracts being let with Russian institutes. These contracts: 1) established a scope of work for cooperative projects in separations chemistry; 2) initiated contaminant transport activities at the Mayak Production Association; and 3) ensure that intellectual property rights are protected under the PUAE Agreement.

Clyde Frank, Deputy Assistant Secretary, Office of Environmental Management, and Eugeniy Mikerin, Deputy Minister, MINATOM, sign the record of Meeting at the 3rd JCCEM.

DOE Objectives

- Identify and access FSU technologies that accelerate the U.S. cleanup mission, thereby leveraging U.S. investment and providing cost savings.
- Improve access to technical information, scientific expertise and technologies that are applicable to U.S./FSU needs.
- Increase private sector opportunities in the U.S./FSU in the area of environmental restoration and waste management.

The 3rd JCCEM meeting was held in Washington, DC in September 1993. The purpose of this meeting was to review the progress of activities conducted during 1992 and to determine the scope of cooperation for the following year. Areas of cooperation were expanded to include radiochemical processing safety and geologic repositories.

With the end of the Cold War, DOE has the opportunity to benefit from developments in FSU technology that augment and complement its own technology development program. At the same time, the FSU benefits from a cooperative technology development program, by acquiring desperately needed resources from the identification, adaptation, and commercialization of EM-related technologies. Following economic stabilization of the FSU, the U.S. private sector will benefit from FSU environmental restoration efforts. All of these activities advance

U.S. government policy objectives by promoting political and economic stability in the FSU, accelerating defense conversion; halting the "brain drain" from the FSU, and increasing private sector opportunities in the U.S./FSU in the areas of environmental restoration and waste management.

FY93 - Estimate of DOE \$ spent on FSU activities.

Russian Science Stabilization

The end of the Cold War and ensuing financial collapse found the FSU critically lacking funds necessary for the research and development of new technologies to address environmental cleanup requirements. FSU scientists, struggling with hyper-inflation and salary cuts, found themselves to be highly marketable abroad. Although DOE is not funding the development of FSU infrastructure, it can assist in curtailing the exodus of scientists by using and employing their knowledge on cooperative projects conducted in the FSU. By contracting with FSU scientists, the U.S. will benefit financially from a highly leveraged labor force, and the FSU will benefit politically and fiscally.

\$2.1M total EM dollars spent on Russian programs.

Environmental Situation

General Problems

In the wake of the collapse of the Soviet Union and with the end of the Cold War, the U.S. and FSU are coming to terms with the environmental legacy and by-products produced from the arms race. Many dangers are posed by current conditions and results of past practices, including: leaking or deteriorating containment vessels; seepage of radioactive or chemical wastes into ground water; contamination of rivers and lakes; transport of airborne contaminants; soil contamination; identification and separation of collectively stored wastes; handling and treatment of those wastes; and the permanent storage of those wastes. All of these issues demand attention and illustrate the need to redirect resources from weapons production to environmental restoration and waste management efforts.

Comparison of the DOE and FSU Complexes

DOE has approximately 4000 contaminated sites covering tens of thousands of acres replete with contaminated hazardous or radioactive waste, soil, or structures. It has more than 250,000 cubic meters of transuranic waste and millions of cubic meters of low-level radioactive waste. In addition, DOE is responsible for thousands of facilities awaiting decontamination, decommissioning, and dismantling. Consequently, EM faces major technical, planning, and institutional challenges in meeting its expanded environmental responsibilities while controlling cost growth.

The FSU also operates a vast radioactive waste complex. Accidents at reprocessing sites and discharge of radioactive waste into the environment have caused significant environmental damage. Increasing public concern and international scrutiny have resulted in environmental restoration and waste management issues receiving greater emphasis and attention.

One example of a highly contaminated region is the formerly secret site Chelyabinsk-65. Chelyabinsk is managed by the Mayak Production Association and is the FSU's first weapons materials production site. Chelyabinsk-65 suffered a devastating accident in 1957, when a high-level liquid waste tank experienced a failure in its cooling mechanism and exploded. The resulting fire spread nitrates

"The plow" used to "bury" radioactive contamination from the 1957 HLW tank explosion at Mayak.

and acetates throughout the region, such that extreme health risks remain today. This unfortunate accident provides a rich source of data and information that can be used to verify EM contaminant transport models, develop risk based standards, and evaluate health effects.

Hanford and Chelyabinsk-65 are similar in that they share historical missions, site contamination, experience in the transition from weapons production to environmental restoration, and a new emphasis on worker retraining. These similarities have created interest in U.S./FSU cooperative programs that work towards resolving the environmental

problems each country faces. It must be stressed that the best solution to environmental contamination from the weapons complexes in both countries involves working together and sharing technologies. The FSU is unique in that past practices offer an unprecedented opportunity to learn certain aspects of contaminant migration and conduct integrated demonstrations, to the mutual benefit of both countries. This, in fact, is the intent of the work being done by DOE and organizations within the FSU.

Science and Technology Process

Technology Development Projects

DOE has implemented a technology evaluation and demonstration process to identify and access technology development efforts at key FSU institutes applicable to EM needs. This process allows the U.S. to evaluate the qualifications and credentials of key FSU scientists, the potential interest, and the likelihood of success of cooperative technology development programs at a relatively low risk. The four phases of the process are described in the figure at left.

The phased technology development process assures that the technology is applicable to EM efforts and allows additional project investment when progress is confirmed. The technology development program guarantees a cautious approach to investing in the FSU and assists in the development of business, legal, and contractual relationships with FSU institutes, while leveraging U.S. investment at a ratio of 50:1. All technology development projects conducted in the FSU must assist in the DOE domestic cleanup mission.

Several different contractual arrangements were evaluated to demonstrate that subcontracts with FSU organizations can be established and managed in full compliance with both U.S. Government procurement practices as well as the laws of the Russian Federation. DOE's mechanism for working with the FSU is designed to be conducted under the same contract procedures as it would with a U.S. company. This contract mechanism ensures fiscal accountability and provides an audit trail. In addition, a significant effort was undertaken to include protection of intellectual property rights and proprietary data rights within contractual documents.

Technology evaluation and development process

- Phase I
 - \$5-10K contract with Russian organization
 - Verify fiscal accountability
 - Test technical capability of organization
- Phase II
 - Experimental research program
 - Let larger scale contract \$50-150K
 - Negotiate protection of intellectual property rights
- Phase III
 - U.S. testing of Russian technology
- Phase IV
 - Technology transfer, and commercialization

Key concepts

- Program directly supports EM mission and priorities
- Most highly leveraged program in EM
- Meets/leads Administration objectives with the FSU

Case Study: Khlopin Radium Institute

A recent example of this process was the initiation of projects between the Khlopin Radium Institute and DOE through Sandia National Laboratories (SNL) and Science Applications International Corporation (SAIC). A technology develop-

ment project was begun in August 1992, to establish the integrity of contract mechanisms and technical approach to be used by the Khlopin Radium Institute. Further agreements were reached under the DOE/MINATOM MOC and project definition and contract negotiations were completed. Following a U.S. commitment to provide for the protection of intellectual property rights of both parties, agreements were reached

Status of FSU technology development.

and a series of scientists' exchanges and major workshops were conducted to trade experience and knowledge, and support contract discussions. Presently, Russian scientists are working on an extensive evaluation of waste separations chemistry, which can be applied to U.S. high-level waste. Khlopin Radium Institute scientists are performing experimental evaluations of a cobalt dicarbollide-based separations process and its application to representative U.S. waste, in cooperation with scientists at Idaho National Engineering Laboratory. This effort has resulted in not only enhanced technology for the U.S., but provided an example of mechanisms for future cooperative projects with Russian and the rest of the FSU.

Intellectual Property Rights

Prior to entering into contracts with FSU institutes, DOE had to resolve the issue of intellectual property rights. At a time when political and legal uncertainties overshadow the FSU, it was vital that both countries assure each other of their commitment to mutual professionalism, respect, and advocacy of the law. DOE used standard U.S. government flowdown Intellectual Property Rights protection language.

Laboratory at Gatchina operated by Khlopin Radium Institute.

When negotiating the Khlopin Radium Institute contract, two of the key areas addressed were limited technical data rights and issues dealing with preexisting data. Limited technical data rights or preexisting data or knowledge (i.e. any preexisting knowledge held by the Russians prior to entry into the contract) can only be used by DOE in terms of evaluating the project being conducted under the contract. New data or knowledge generated under the contract can be used by both sides. The U.S. and Russia have unlimited rights in these circumstances. If the U.S. desires to use new data for purposes outside of the scope of the contract, then the U.S. must enter into a licensing agreement with Russia.

Technical Projects

To achieve its mission, DOE must develop innovative technologies rapidly and in accordance with applicable regulations. The mission of the Office of Technology Development is to direct an aggressive campaign for applied research and development to resolve major technical issues and rapidly advance EM's cleanup program. In addition to research and development activities in the U.S., efforts have been made to access international technology and experience.

Separations

At the first JCCEM meeting in Moscow in 1990, it was agreed that a technical exchange would occur in the area of separations technologies. The need for separations technology is particularly important with respect to the treatment of waste streams at Idaho, Hanford, and Savannah River sites. The mixing of waste streams at these sites make them difficult to identify, treat, and ready for final disposal.

JCCEM Separations Project

In FY 1993, DOE initiated an experimental research program with the Khlopin Radium Institute to study the possibility of applying the cobalt dicarbonyl

"The Technical projects that comprise this DOE program serve U.S. science and technology needs while providing Russian scientists with an opportunity for independent and sustained growth in the competitive world environmental market."

Clyde Frank
Deputy Assistant
Secretary for EM

Separations Technical Exchange Workshop: St. Petersburg, Russia.

process to the pretreatment of the liquid phase of U.S. wastes. The studies were conducted on synthesized waste samples, and demonstrated that a suitable flowsheet could be developed for the liquid complex concentrate waste form. Data were also provided on the degree of separation of the long-lived isotopes and indicated that significant cost savings could be realized due to the reduction of the volume of high-level wastes (HLW).

Boris Zaitsev, of the Khlopin Radium Institute, displays simulated Hanford waste.

Based on the results of the technology development project, a technical approach and statement of work was developed with the objective of obtaining initial data on the applicability of the Russian cobalt dicarbollide process for separation and management of radioactive wastes. The research program will be conducted over a three-year period with the first year

consisting of three tasks:

- laboratory investigations on reprocessing of simulated solid phases of high-level waste
- design and construction of a test facility for dynamic testing
- dynamic trails of reprocessing technology applied to simulated high-level waste.

One of the most effective ways to reduce the heat generation and immediate hazard of many liquid nuclear wastes is to remove the cesium and strontium isotopes from wastes. To minimize the volume of wastes produced, these elements should be removed in as pure a state as practical. One interesting and

Cobalt Dicarbollide $\text{Co}(\text{C}_2\text{B}_9\text{H}_{11})_2^-$

effective approach to this problem was developed in Russia and Czechoslovakia, and is used today in Russia. This approach involves the use of an unusual molecule, cobalt dicarbollide, which has a high selectivity for removing cesium from acid solutions while leaving essentially all of the other materials with the waste solutions. By use of an additive, cobalt dicarbollide can be made to remove strontium as well.

Cobalt dicarbollide (ChCoDiC) is an interestingly shaped molecule that consists of two "cage-shaped" carbollide groups attached to a cobalt ion. Each carbollide group carries a -2 electric charge, and the net charge from the two carbollide groups is only neutralized by the +3 charge of the cobalt ion. This leaves a net charge of +1 that can be neutralized by a positively charged metal ion. The interesting property of cobalt dicarbollide is its strong tendency, under the proper conditions, to prefer cesium or strontium. It is this property that makes it so potentially useful in treating nuclear waste solutions. The separation process involves dissolving the cobalt dicarbollide into an organic solvent that is insoluble in the nuclear waste solution. Then, when the waste solution and solvent are mixed and dispersed, the cesium or strontium contaminant moves from the solution to the solvent. The solvent can then be allowed to separate from the dispersion, and the solvent containing the contaminant is removed from the system. The contaminant can then be chemically removed from the cobalt dicarbollide in a second step, and the cobalt dicarbollide and solvent can be recycled. The contaminant solution can be concentrated or even dried to give a concentrate suitable for packaging for disposal with minimal volume. Additional efforts are currently being directed at the identification of alternative diluents to the aromatic nitrobenzenes, currently implemented in the Russian commercial process. Scientists at the Khlopin Radium Institute are investigating, under a DOE-sponsored contract, the feasibility of applying this technology to U.S. DOE defense-related wastes.

*On Cobalt
Dicarbollide:
"It's been studied
in this country for
20 years, but the
Russians have the
capability and
have generated a
lot more
information than
we have."*

Teresa Fryberger
*Program Manager
for Efficient
Separations and
Processing
Integrated
Program*

U.S.-Russian Separations workshop participants.

When working with the Russians (or any foreign group), one-on-one interactions between U.S. and foreign scientists are extremely important, particularly in areas where environmental regulations play a large role in technology selection. To initiate such interactions, DOE sponsored a three day U.S.-Russian workshop on cobalt dicarbollide technology in Tucson, AZ last February, which stimulated U.S. scientific interest in the technology. Khlopin Radium Institute scientists are now working with colleagues at the Idaho National Engineering Laboratory and at Hanford to test the use of cobalt dicarbollide with actual U.S. DOE radioactive wastes at these sites. Actual tests are to begin in the Spring of 1994.

This collaborative effort is one example of how the U.S. is learning of new technologies that were originally developed in Russia and other formerly eastern block countries, and evaluating their potential use for solving problems with U.S. nuclear wastes. The difficulties, potential risks, and costs of treating nuclear waste are so great in all countries that it is important to utilize the best technologies and the best experts to develop those technologies. Separation of long-lived radionuclides from defense HLW affords significant reduction of required glass volume for disposal. According to U.S. estimates, DOE could realize a program cost savings of up to \$14 billion. The technical expertise in Eastern Europe is very good and they have investigated technologies that have not been evaluated in the West. This joint development program combined with the appropriate experts promotes cooperation among the countries and provides the fast and less costly development, so that technologies can be optimized and used more effectively in the U.S. and other countries.

Using Crown Ethers for Removal of Long-Lived Radionuclides and Toxic Metals from Low- and High-Level Radioactive Wastes

crown ether

DOE is initiating a project with the Russian Research Institute of Chemical Technology, known as "KHIMCONVERS", to evaluate a Russian developed technology for using crown ethers for removal of long-lived radionuclides and toxic metals from low- and high-level radioactive wastes. The project will also study the ability of crown ethers to control chemical (redox potential) conditions in alkaline waste and process solutions.

Crown ethers are compounds consisting of carbon and oxygen. The electronegative nature of the oxygen forces it to bind to metal substances, allowing for separation. For that

reason, the crown ethers have the potential to be customized to extract particular elements.

The project consists of several tasks:

- review of the existing methods and techniques developed in Russia for separation of long-lived radionuclides (Sr, Cs, and actinides) and toxic metals (Pb, Hg, and others) from aqueous solutions using crown ethers
- review the existing experience of Russian implementation of such techniques in large scale decontamination activities
- identify potential experience of Russian extraction technology for waste management and environmental remediation needs in the DOE weapons complex.

DOE is preparing specifications for experiments with contaminated wastes. Participants will be identified for the experimental research program and recommendations for future work will be made (e.g. experimental demonstrations of the applicability of Russian liquid-liquid extraction techniques to specific DOE waste management and environmental problems).

Transuranic (TRU) Waste Treatment via Calcination/Dissolution

DOE is funding research in Russia on an aqueous waste separations project called "TRU Waste Treatment via Calcination/Dissolution." The calcination/dissolution approach to treating Hanford high-level waste (HLW) proposes using high temperatures ($>500^{\circ}\text{C}$) to calcine and decompose certain troublesome components of the waste. The calcination is followed by partial water dissolution. The relatively low volume of water-insoluble material (including, it is suggested, the TRU elements) is separated from the water-soluble salts. The water-insoluble materials then are subjected to glass immobilization while the water-soluble materials are fed to grout.

The disposition of the TRU elements is key to the calcination/dissolution process and is dependent upon the chemical environment existing in both the calcine and the aqueous phases. This subtask identifies studies aimed to elucidate the TRU chemistry in the melt and aqueous systems.

The technical performance involves a proposal to bring the Hanford HLW rapidly to 850°C calcine temperatures via plasma heating. A pilot-scale calcine demonstration has been performed with promising results, using synthetic wastes

Potential Benefits to DOE

Russian research has focused on the development of inexpensive ion exchange media. These developments can reduce the costs of DOE operations involving decontamination of groundwater.

simulating Hanford Tank 101-SY slurry. The objectives of calcination are to destroy organic molecules/ions present in the waste; convert salts, such as nitrate, to the corresponding oxides/hydroxides; and, if possible, use the sodium hydroxide (NaOH), present in the HLW and produced via calcination/dissolution, as a fluxing agent to solubilize phases, such as $\text{Al}(\text{OH})_3$ and aluminosilicates, known to be present in the sludges of the HLW. At the end of calcination, the HLW will be essentially a molten solution of metal oxides, aluminates, silicates, phosphates, sulfates, and chlorides in a NaOH solvent.

In the dissolution step of the calcination/dissolution process, the NaOH-based solid solution will be treated with water. The key to the calcination/dissolution approach is the assumption that the transuranic elements (specifically neptunium, plutonium, and americum) will stay water-insoluble and thus be present in the relatively small volume of metal oxide/hydroxide sludge remaining for long-term immobilization in glass. The water-soluble phase, containing the short-lived fission products, would be fed to the grout process.

Adsorption Technology for Removal of Long-Lived Radionuclides from Low- and Medium-Level Aqueous Solutions

The Institute of Physical Chemistry, Russian Academy of Sciences, is working with DOE on developing adsorption technology for removal of long-lived radionuclides from low and medium level aqueous solutions. Ever increasing

Applying Russian technology to EM HLW treatment needs.

development of the nuclear industry and current operation of nuclear power reactors of different types create large volumes of liquid radioactive wastes, most of them being low and intermediate level. Among the radionuclides present in waste composition, the long-lived strontium and cesium radionuclides possess the highest biological hazard. Therefore, removal of those species from low and intermediate-level waste streams is a very important issue. Several technologies have been investigated for large-scale decontamination efforts in Russia. Technologies under consideration include chemical precipitation, coagulation, electrodialysis, and ion exchange.

Ion exchange treatment of low-level radioactive waste and intermediate-level radioactive waste based upon adsorption of radionuclides on organic ion exchange resins, natural mineral and organic material, and synthetic inorganic adsorbents is one of the most efficient techniques used for the purpose. A number of natural and synthetic ion exchange media have been evaluated for application to large-scale decontamination problems.

Technical Projects

Characterization and Contaminant Transport

The Chelyabinsk site, in the southern Ural Mountains of Russia, presents an unfortunate but unique opportunity to study transport of radioactive contaminants in soils and groundwater systems. During past operations and accidents at the site, radioactive materials were directly released to the environment. The 1957 high-level liquid waste tank explosion at Chelyabinsk released 2 million curies and scattered radioactivity along a track over 200 km long and an area over 1000 km square. From 1949 to 1952, medium-level wastes were directly discharged into the Techa River. After 1951, medium-level wastes were continuously sent to Lake Karachai, which currently contains 120 million curies of radioactive wastes. In 1967, the water level of Lake Karachai decreased significantly, allowing for the airborne release of 600 curies. In comparison, the Three Mile Island accident released 5-50 curies. At Chelyabinsk, approximately 1 billion curies of high-level liquid wastes are stored in tanks, as vitrified wastes in bunkers, and as buried solid wastes.

Since the early 1960's, data were collected at the Chelyabinsk site (5m to 100m in depth). Though the quality of the data needs to be evaluated, they form a data base that can be used to study various physical and chemical processes present during radioactive contaminant transport. Characterization and contaminant transport projects are centered around the information gathered from the Chelyabinsk region. This data and the exchange of Russian experts familiar with the region will assist in the validation of U.S. mathematical models and the establishment of risk-based standards for evaluation of U.S. contaminated sites.

JCCEM Contaminant Transport

A project between Lawrence Berkeley Laboratory (LBL), Sandia National Laboratory (SNL), Pacific Northwest Laboratories, the Khlopin Radium Institute, the Mayak Production Association, Moscow State University, Vernadsky Institute, and the St. Petersburg Mining Institute was established in the area of contaminant transport modeling to analyze site characterization efforts at Chelyabinsk. The projects involves the exchange of data sets, independent modeling of the data, and comparison of results. The current project will be expanded to include field tests and measurements at the Chelyabinsk site.

"The issues are not only national, they're international. I believe that this country and all other countries are going to come together, relative to the environmental restoration of the world."

Thomas Grumbly
Assistant Secretary
for EM

FY '93 Technical Focus

1. Chelyabinsk region, southern Ural Mountains
 - radioactive wastes from nuclear development from 1950 to 1994
 - extensive soil, river and groundwater contamination
 - tank explosion in 1957; large area contaminated
 - over 40 years of data
2. Lake Karachai, Chelyabinsk region
 - direct discharge of radioactive brine, still continuing
 - 120 M Ci
 - infiltration into groundwater
 - migration to nearby river
3. Major field visit and testing program planned for June/July 1994
 - work to be carried out by joint Russian/U.S. team
 - soil sampling: samples to U.S.
 - well testing: vertical characterization
 - new wells (up to 3) will be drilled and tested

The first project consisted of a workshop on contaminant transport modeling held at the Russian American Center for Contaminant Transport Studies at LBL on July 7-9, 1993. Participants included the Russian Center Fellows, representatives from the Consulate General of Russia, DOE, U.S. National Laboratories, U.S. Geological Survey, universities, and private industry. The workshop is the first concrete step of Russian-American scientific cooperation after many years of general discussions and plans. Data on the hydrogeology surrounding Lake Karachai was provided for discussion of weathered and fractured formations, and migratory trends of heavily contaminated plumes. Information on the geochemistry of the cascade of reservoirs along the Techa River was collected and reviewed. The Techa River information included hydrochemical data of acids and radionuclides in bottom sediments and in reservoir water. Preliminary modeling studies were initiated to investigate important physical and chemical processes in the soil and groundwater systems at Chelyabinsk, as well as to address possible remediation strategies.

Using Russian data to validate U.S. models.

Russian American Center for Contaminant Transport Studies

EM and the Office of Energy Research cosponsored the opening of the Russian American Center for Contaminant Transport Studies at LBL, in June 1993. The purpose of the Center is to advance the knowledge of contaminant transport and to provide in-depth interaction and technical exchanges for U.S. and Russian scientists. Four to six Russian scientists will be invited annually by DOE to work at the Center to provide input into U.S. environmental remediation problems for periods of one to three months. The Center allows for U.S. and Russian scientists to collaborate on studies of site characterization of contaminated sites and alternative remediation strategies. It also coordinates the research efforts of the Russian Center Fellows and U.S. scientists, and addresses the technical emphases of different agencies through workshops and status reports.

Russian Report List

Authors	Report Title	JCCEM	Affiliation
'Drozhko, E.G., 'Mironenko, V.A., 'Pozdniakov, S.P., 'Samsonova, L.M., 'Shestakov, V.M.	Previous investigations and field hydrogeological data for Chelybinsk region	X	'MAYAK' Production Association, Chelyabinsk, Russia
'Drozhko, E.G., 'Mokrov, Yu.G., 'Glagolenko, Yu.V., 'Samsonova, L.M.	Determination of hydrodynamic parameters of cleaved rock mass according to regime examination data in the Lake Karachai area	X	'Vernadsky Institute of Geochemistry and Analytical Chemistry, of the Russian Academy of Sciences, Moscow, Russia
'Drozhko, E.G., 'Samsonova, L.M., Zinin, A.I., Yinkin, V.P.	Computer model of solutions unsteady migration in groundwater	X	'Gidroapeloogia, Ministry of Atomic Energy, Moscow, Russia
'Mironenko, M.V., 'Spasennykh, M. Yu., 'Polyakov, V.B., 'Ivanitskii, S., 'Garanin, A.V., 'Voloosov, A.G., 'Khodakovskii, I.L., 'Smimov, A.B., 'Mokrov, G. Yu., 'Glagolenko, Y.G., 'Drozhko, Eu. G.	The cascade of reservoirs of the "MAYAK" plant: case history and the first version of a computer simulator	X	'Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry of the Russian Academy of Sciences
'Mironenko, M.V., 'Rumynin, V.G.	Analysis of hydrogeological consequences of hazardous accidents at designed nuclear reactors: forecast and field investigation	X	'Moscow State University, Moscow, Russia
'Mironenko, M.V., 'Rumynin, V.G., 'Shestakov, V.M., 'Konosavsky, P.K., 'Pozdniakov, S.P., 'Roshal, A.A.	Development of analytical and numerical models for the assessment and interpretation of hydroecological field tests at the key sites of the Lake Karachai area		'St. Petersburg Mining Institute, St. Petersburg, Russia
'Pek, A.A., 'Malkovsky, V.I.	Modeling of the fault-controlled hydrothermal ore-forming systems		'Geosoft-Eastlink
'Malkovsky, V.I., 'Pek, A.A.	Computer simulation of nuclear waste transport from the deep drift hole repository: thermal convection model		
'Pek, A.A., 'Malkovsky, V.I.	High-level nuclear waste geological disposal: utilization of HLW heat generation in the design of engineering barriers		
'Pozdniakov, S.P., 'Shestakov, V.M.	Quasi-D variable density flow model		

1993 Center Fellows

Valery Mironenko	St. Petersburg Mining Institute	April 93 - August 93
Alex Pek	Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry of the Russian Academy of Sciences	May 93 - July 93
Victor Malkovski	Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry of the Russian Academy of Sciences	May 93 - July 93
Mikhael Mironenko	Vernadsky Institute of Geochemistry, Moscow	May 93 - July 93
Sergey Pozdaikov	Moscow State University	July 93 - July 94

Application of U.S. Models: RESRAD and MEPAS

The introduction and delivery of two types of computer codes to Russia, RESidual RADioactivity (RESRAD) and Multimedia Environmental Pollutant Assessment System (MEPAS), provides an opportunity to assess environmental contamination and risks to human health, while offering significant cost savings by avoiding unnecessary cleanup. The RESRAD computer code was developed at the Argonne National Laboratory for the purpose of calculating site-specific guidelines for assessing the degree of contamination at a given location. For the purposes of code validation and verification, it is necessary to compare the results of RESRAD calculations with results from other codes and results from actual sites. Interaction with scientists from the FSU will permit comparison of predicted code results with actual experience in contaminated areas. These activities will help confirm that the code is scientifically valid and adequately protects public health. The issue of cost reduction is closely linked to domestic regulatory code acceptance. In 1993, DOE spent over \$1 billion for the cleanup of radioactively contaminated soil and debris. With the regulatory acceptance of the risk-based standards established using RESRAD, DOE could recognize significant cost-savings from avoiding unnecessary soil cleanup.

MEPAS, developed at Pacific Northwest Laboratories (PNL), serves as a means to estimate the impact of released contaminants on the environment and human health. The model was developed to rate DOE sites and their potential hazard from release of contaminants. MEPAS calculates a "Hazard Potential Index" (HPI) for a site by gathering and assessing risk factors associated with various scenarios. Population exposure is determined by evaluating contaminant transport through four means:

- groundwater
- surface water
- overland flow
- atmosphere

In addition to magnitudes, the system provides information on the type, time, and location of impacts. These risk-based indicators provide a basis for assigning priorities to environmental problems, and MEPAS has been used to prioritize potential problems related to different sites.

MEPAS is applicable to a wide range of potential environmental problems involving various stages of problem characterization. The system handles problems involving radionuclides and chemical carcinogens as well as non-carcinogens, any of which can originate from landfills, stacks, pipes, and other sources. MEPAS can be operated with contaminant source-term data obtained during the

early stages of problem investigation, allowing it to be applied in a preemptive manner to a variety of environmental problems and locations.

Network for Characterization and Monitoring

DOE initiated a technology development project with the Institute of Spectroscopy, Russian Academy of Sciences, for development of a network for the characterization and monitoring of environmental contamination in Russia. The network is designed to coordinate the environmental monitoring activities of government and commercial entities, incorporating existing, as well as proposed, monitoring stations. The network will comply with all toxic substance control regulations and will include analyses for all priority radiochemical and chemical substances.

The Institute of Spectroscopy established a Council of Experts to oversee the implementation of the network and to provide for two reports on the structure of the network. The first report will include the location of at least 50 monitoring stations, an assessment of sampling capacity and analytical capability, the location of deficiencies in analytical capability, the selection and identification of the Council of Experts, and a strategy for achieving the required analytical capability. The second report will include an outline of a sampling and analysis training course.

Laser Evaporation Technology for Environmental Sample Preparation

A technology development project was established with the Khlopin Radium Institute to evaluate the applicability of Russian technology for using laser evaporation technique for environmental sample preparation. This technology uses lasers to evaporate environmental materials which are suitable for generating atomic beams that can then be analyzed by tunable laser high-resolution spectroscopy. This direct isotopic analysis of environmental samples may serve as an alternative to procedures involving traditional wet chemistry and radioactive counting.

Wet chemistry techniques for environmental sample preparation are limited in accuracy to a few percent since they depend on the completion of chemical reactions. The laser techniques are, in principle, higher in precision (1-2 orders of magnitude), faster (minutes vs. days), and cheaper (2 orders of magnitude reduction in cost per sample). Environmental sample preparation is a significant cost for characterization of contaminated sites.

A sample is placed into a vacuum chamber (evacuated to 10^{-6} mm Hg) in a holder that permits it to be either heated electronically to 1500°C or subjected to evaporation by an intense laser beam. The registration of induced fluorescence, of time-of-flight mass spectra, of ionized evaporation products, and of laser resonance ionization products from the evaporated material is possible. This technology can characterize the radioactive components of environmental samples and specimens (e.g. plutonium and uranium in soils).

Technology Description

Laser techniques have been developed for preparation and direct isotropic analysis of environmental samples as an alternative to normal procedures involving wet chemistry and radioactive counting

Status

This technology is in research and development

Potential Benefits to DOE

Laser techniques offer:

- Better accuracy ($>0.01\%$ vs $\sim 5\%$)
- Faster (minutes vs weeks)
- Cheaper ($\sim \$1$ vs $\$200$ sample)

This technology could be very important to large environmental characterization projects.

Technical Projects

Waste Treatment

DOE activities in waste treatment and removal have involved aggressive investigation and implementation of innovative and cost-saving technologies, which include technology development projects in the treatment mixed waste off-gases and vitrification.

Applications of Catalysts to Treatment of Mixed Waste Off-Gases

The Boreskov Institute of Catalysis and DOE have initiated a technology development project to evaluate "Applications of Catalysts to Treatment of Mixed Waste Off-Gases." Selective Catalytic Reduction (SCR), using ammonia as a reducing agent, is currently a preferred method of treating NO_x in off-gases. The advantages of SCR over methods such as wet scrubbing are compact design, low maintenance, absence of gas cooling requirements, and absence of secondary wastes. Any further improvements in catalyst design would lower the costs, improve their resistance to poisons, expand their ability to promote oxidation/reduction in mixtures such as NO_x/CO, and increase their mechanical strength. An additional requirement of catalysts for use in California is that the catalyst formulations meet the California Land Ban disposal restrictions. The Boreskov Institute of Catalysis formulated and shipped a new iron/chromium/zinc oxides monolith honeycomb catalyst with improved mechanical strength and higher activity, as well as a Honeycomb Catalyst Testing Unit to LLNL as a result of their past work together. Initial testing of this catalyst has been completed and its performance in NO_x destruction has exceeded expectations.

Underground Waste Storage Facility in the FSU.

There will be two tasks involved with "Applications of Catalysts to Treatment of Mixed Waste Off-Gases":

- 1) A technology development project involving a "DeNOx Catalysts for Improved Off-Gas Treatment". This activity will generate baseline data for NOx reduction catalysts and development of a rapid (accelerated) catalytic activity testing method. Preparation of modified (improved) monolithic honeycomb catalysts (8 samples: 75 x 75 x 150 mm) for eventual transfer to and testing at LLNL will be initiated
- 2) Three reports will be prepared discussing state of the art details of the following waste treatment technologies: 1) photocatalytic decomposition of hazardous volatile organic compounds via heterogeneous gas-phase catalysis; 2) wet catalytic oxidation of organics by molecular oxygen; 3) decomposition of hazardous chlorinated organic compounds via catalytic hydrogenation.

JCCEM Vitrification

Vitrification activities include an exchange of information on glass melter designs and on the treatment of high-level wastes to ensure safe disposal. The first vitrification technical exchange workshop was held in October 1991, in Chelyabinsk, Russia. As a result of the workshop, a project involving the exchange and analysis of glass samples between the two countries was initiated.

An induction melter similar to this one will be tried on "an industrial" basis at Mayak.

Glass samples were exchanged between the Savannah River Site (SRS) and Mayak in July 1992. Russia sent two samples of their phosphate glass, containing simulated waste, to the Savannah River Technology Center (SRTC). U.S. glass samples were shipped in April 1993. Characterization of the samples is currently underway, and the Russian and SRTC preliminary results showed many similarities. Both glasses were tested with the Product Consistency Test (PCT), developed at the SRS for testing the durability of radioactive glass that will be produced in the Defense Waste Processing Facility (DWPF) at SRS. The two Russian glasses are more durable than two other phosphate glasses developed in the U.S. One Russian glass was analyzed by X-ray diffraction and found to be amorphous, indicating complete vitrification. However,

heating the glass for 18 hours caused devitrification and the precipitation of sodium aluminum phosphate.

The U.S. analysis of the Russian glass continues in the following areas:

- 1) Determine the concentration of trace metals in the glasses and the isotopic composition of the uranium using mass spectroscopy.
- 2) Analyze the PCT leachmates by mass spectroscopy for trace metals.
- 3) Analyze the glass containing uranium by X-ray diffraction and heat treat the glass to look for possible uranium precipitation.
- 4) Examine both glasses by scanning electron microscopy and the nonradioactive glass by transmission electron microscopy, for phase separating and possible noble metal agglomeration.
- 5) Attempt to model the relative durability of the glasses by the thermodynamic hydration model developed at SRTC.

Russia-Vitrification

Plasma Furnace Technology for Vitrification of TRU Contaminated Wastes

A technology development project was initiated between Sandia National Laboratory, the Institute of Chemical Technology, and the Mayak Production Association in the use of plasma furnace technology to vitrify TRU contaminated wastes. A technology has been developed in the U.S. for vitrification of TRU wastes that

uses a plasma torch. The technology has been demonstrated on a pilot-batch scale with contaminated wastes, and the current project is evaluating the disposition of TRU materials between the metallic, glass, and gaseous phases. This project is intended to show that combined induction furnace and plasma torch technologies used for direct vitrification of TRU wastes provide a high degree of control of metallic, glass, and gaseous phases during the melting process. EM is considering cooperation with appropriate Russian research institutes to perform similar experiments. The purpose of this technology development project will be to review Russian technology for vitrification of TRU contaminated waste, and to assist in the preparation of an experimental plan for the proposed experiments.

A report describing Russian technology and experience for processing TRU contaminated waste into a form suitable for geologic storage will be prepared. The report will identify Russian institutes and scientists possessing relevant experience with this technology for participation in an experimental program. This report will be presented both in Russian and English.

The U.S. side will prepare specifications for proposed experiments with TRU contaminated wastes. A plan for the specified experiments will be developed to identify facilities and participants for an experimental research program. A report addressing the potential applications of this high-temperature, vitrification technology for TRU contaminated wastes, and a preliminary evaluation of their ability to support a U.S. defined experimental research program, has been developed.

Technology Description

Combined RF furnace and plasma torch technologies for direct vitrification of contained transuranic wastes provide a high degree of control of metallic, glass and gaseous phases of the melting process.

Status

The technology has been demonstrated on a pilot batch scale with contaminated wastes. The current project is evaluating the disposition of transuranic materials between the metallic, glass, and gaseous phases.

Potential Benefits to DOE

Russian technology complements ongoing U.S. technology developments providing the opportunity to reduce cost, schedule and risk technology development through development of a cooperative research program.

Technical Projects

Environmental Restoration

Electrokinetic Extraction Process for Soil Remediation

DOE, in collaboration with the FSU, is evaluating and demonstrating the use of electrokinetics for the cleanup of soils and groundwater contaminated with heavy metals. Russian scientists have extensive knowledge of electrokinetic remediation of sites contaminated with heavy metals (lead, mercury, cadmium, etc.), radioactive species (Cs-137, Sr-90, Co-60, etc.), and anionic species (nitrates, sulfates, etc.). An extensive portion of the FSU scientists' experience with electrokinetics has been with uranium contaminated soils.

Electrokinetic phenomena in soil can be divided into three categories: electrophoresis - the movement of soil particles within the soil moisture or groundwater; electroosmosis - the movement of soil moisture or groundwater from the anode to the cathode; and electrolysis - the movement of ions and ion complexes within the soil moisture or groundwater. These phenomena occur when the soil is electrically charged with direct current. The fundamental configuration for all three processes involves the application of an electrical potential between one or several electrode arrays in physical contact with the soil, in order to cause migration of positive species to a cathode and negative species to an anode. Of the three electrokinetic phenomena, electrolysis has the most applicability for remediation of uranium, plutonium, and other toxic metals at DOE sites, since these contaminants may exist in an immobile phase (i.e. solid oxides, entrapped particulates, etc.) and may require solubilization into an electrolytic medium for mobilization during in situ treatment.

Clyde Frank and Eugeniy Mikerin at the 2nd JCCEM meeting in Moscow.

This project includes pilot-scale demonstration of electrokinetic removal of uranium from contaminated soil. Site selection and treatability studies will precede the pilot test, and a full-scale field test, at a site to be determined, is

envisioned following evaluation of the pilot scale results. Removal efficiency, control of added fluids, contaminant recovery and disposal, power consumption, mass balance, and control of soil pH all must be evaluated to assure that this process is viable. Technology advances made by Russian scientists in this area of environmental remediation will be used as much as possible. The site should be selected to allow easy permitting for testing, be representative of the uranium problems throughout the DOE, and be accessible to industry, regulatory agencies, and academia.

Remediation of uranium-contaminated soil is one of the major cleanup tasks facing DOE. In situ methods are needed that can remove enough uranium to reduce contaminant concentrations to acceptable levels and allow the soil to return to productive use. Electrokinetic methods are being evaluated for this purpose, and applicability to uranium removal from saturated and partially saturated soils needs to be documented.

Electrokinetics Process.

Soils from the K-311 and K-25 sites at Oak Ridge are being analyzed for treatability by electrokinetics, with results contrasted to previous characterizations made at the Drum Storage Area at the Fernald Site. The latter site has shown good response to carbonate leaching if electrokinetics can be used to move the solubilized uranium through the silty clay soil. Other Oak Ridge sites may also be identified for treatability analysis. A report has been prepared by Hazardous Waste Remedial Action Program (HAZWRAP) and K-25 personnel summarizing initial site selection sampling activities. Regulatory and criticality issues are being investigated by K-25 personnel. Initial soil characterization studies involv-

ing distributed soil samples will be finished shortly and plans for acquiring undisturbed samples are underway.

A suitable site for electrokinetic remediation will be selected on the basis of the treatability data and the site requirements for cleanup. A qualified industrial partner will be selected to conduct the field demonstration in FY 1994. HAZWRAP personnel have visited sites in Russia where electrokinetics have been used to remediate uranium contamination from soil. This information will be useful in developing the technical specifications for demonstrations at DOE site.

BEFITO Biomass Remediation

DOE is testing and evaluating soil and water remediation technologies developed in the Ukraine at the DOE Component Development and Integration Facility (CDIF) in Butte, Montana. MT International, a sub-contractor, has a joint venture agreement with the Central Scientific Research Laboratory of Comprehensive Processing of Plant Raw Materials, often referred to as "BEFITO." This organization is part of the Ukrainian Academy of Sciences, which has focused considerable effort on biomass remediation technologies and has tested them at Chernobyl.

Befito Process

Technical exchange discussions were held in the U.S. in the Fall of 1992, to address the "BEFITO" process, which involves using selected plant species that accumulate heavy metal and/or radionuclides in their leaves and stalks. Plant material is harvested and subjected to fractional separation processing that extracts and concentrates the contaminants and produces nonhazardous by-products.

The project goal is to demonstrate the Fractionation Separation Technology (FST) at a DOE site and to determine the feasibility of using macrophyte (macroscopic plant life) bioremediation to treat soils, sediments, and surface water contaminated by heavy metals and radionuclide wastes. The project first evaluated, at bench scale, the process for growth, harvest, and separation of heavy metal radionuclides from selected biomass grown on contaminated soils. The primary objective of this analysis was to remediate contaminated soils through

bioconcentration. Successful bench-scale testing is being followed by a pilot-scale demonstration at a DOE site.

The feasibility phase will include an assessment of the needs and potential users of the technology. An implementation plan will be developed early in the project to facilitate acceptance by stakeholders and to transfer the technology to an industrial partner. The scope of work will include four activities: 1) needs and applications assessment; 2) confirmation testing of soil biomass; 3) pilot-scale testing of soil biomass; and 4) confirmation testing for expanded applications.

Upon completion of a DOE inspection of Ukrainian equipment being built for demonstration in the U.S., hazardous metal and radionuclide testing began at the CDIF. Upcoming plans include reaching a decision regarding purchase of equipment based on U.S. bench-scale testing of technology in the U.S.; the processing of contaminated plant material from Fernald at the CDIF; and the processing of aquatic plant material. "BEFITO Biomass Remediation" has the potential to be a low-cost remediation of surface waters and soils contaminated with metals. It may provide for contaminant volume reduction with little secondary waste.

Nuclear Energy Agreement to Purchase Pu²³⁸

DOE and the Mayak Production Association signed a contract for the purchase of 5Kg of Pu²³⁸, on December 8, 1992. The contract includes an immediate commitment to purchase 5kg of Pu²³⁸ for \$6,000,000. The Russians have processed the 5kg, and with U.S. assistance have prepared the material for shipment. The contract allows for the U.S. to purchase up to 30kg of Pu²³⁸ from the Russian facility. In addition to the DOE contract with the Mayak Production Association, an agreement was negotiated between DOE and MINATOM covering the purchase of Pu²³⁸. It was agreed that the U.S. will use the Pu²³⁸ for civilian space power applications and Russia will use the hard currency received from the sale for environmental remediation and social rehabilitation of the Chelyabinsk region.

Fossil Energy Memorandum of Cooperation

DOE and the Russian Federation Ministry of Fuels and Energy signed an "Agreement on Scientific and Technical Cooperation in the Fields of Fuels and Energy." on June 17, 1992. The purpose of the MOC was to establish cooperative activities in the areas of fossil energy, related technologies, and associated economic developments to advance the common interests of the parties and their industries in the environmentally acceptable and economic use of fossil fuels and technologies. Article II, Section 3, states areas of cooperation, applicable to EM: *"Environmental assessment, protection, and remediation techniques and procedures considering all aspects of fossil fuel utilization."*

Scientist Exchanges

At the first JCCEM meeting in November 1990, it was agreed that the exchange of senior scientists would be vital in facilitating future cooperation and in the areas of environmental restoration and waste management. A scientist exchange program was established to enable FSU/U.S. scientists the opportunity to investigate the following EM-related issues:

- policy and practices associated with past and current operations relating to the nuclear fuel cycle;
- problems of process design development and operations related to environmental remediation and control of materials contaminated by radioactive and other hazardous waste;
- research directed at improving the effectiveness, economics, safety and public acceptability of methods of handling, storing, and disposing of radioactive waste;
- investigations related to waste partitioning to facilitate permanent disposal;
- investigations related to the geologic disposal of wastes.

Participants of the 4th Annual Weapons Complex Monitor, Applied Research and Technology Colloquium, Phoenix, AZ, April 1993 are, (l to r) Eugene Drozhko - MAYAK, Rebecca Keen - SAIC, Clyde Frank - DOE, Steve Stein - PNL and Igor Khodakovski - Vernadski Institute.

"I never thought we would move as fast as we have. It's a real compliment to the professionalism of scientists around the world, and the respect they have for each other. Without that, the collaboration wouldn't work."

*Clyde Frank
Deputy Assistant
Secretary for EM*

U.S. National Academy of Sciences Grants

On behalf of DOE, the National Academy of Sciences is administering an exchange program on radioactive waste management between scientists from the U.S. and the FSU. The program will provide grants of \$16,000-\$30,000 to support FSU scientists at U.S. national laboratories in the area of environmental restoration and waste management. Awards will cover the costs of international airfare, living allowance, and scientific supplies for a period of up to nine months.

University and Laboratory Exchange

A senior scientist from the St. Petersburg Mining Institute completed a three month exchange at the Lawrence Berkeley Laboratory (LBL) in June 1993. A post-doctoral research assistant from the Moscow State University began a year-long exchange at LBL in May 1993.

Exchange Participants at Washington State University.

In 1994, four Russians will be employed as research assistants at the University of Idaho, Washington State University, and appropriate national laboratories. The Russian graduate students possess expertise in the following areas: applications of superficial fluid extraction of trace metals in the environment; application of chemical modeling to real chemical systems, such as the structure of crown ethers/ion complexes in aqueous solution or the solution phase structure of certain cardiac drugs; and the use

of modeling techniques in the development of realistic nucleation and growth models for the formation of ceramic powders from vaporized feed. These models

Moscow State University.

Benefits from Exchanges

- Assists Scientists' development in a direction that benefits EM.
- Forms contacts and maintains professional relationships that are critical to the success of collaborative projects.
- Training Russian Scientists on U.S. equipment & technologies creates a market for U.S. technologies in the FSU.
- Identifies and accesses Russian technology that would benefit EM.

scientists will go to the Russian American Center.

Environmental Remediation Course

A two-week Environmental Remediation Course was held for Russian scientists in Washington, DC and Richland, Washington in April 1993. The course focused on characterization and cleanup strategies for radiologically-contaminated sites. The first week focused on presenting a national perspective on environmental restoration and remediation issues from representatives of DOE and other U.S. government agencies. The second week showcased activities at the Hanford site, with respect to experience and approaches to the restoration of contaminated sites.

Topics included some of DOE's most challenging issues, such as decontamination and decommissioning of nuclear facilities, waste tanks, radiologically-contaminated soils and groundwater, and innovative technology development and deployment. Sessions were held on public involvement, policy, environmental education, and assessment.

*On the similarities of
Hanford/Cbelyabinsk:*

*"That also was a
completely secret site.
You can see from this
how much the times
have changed. I think
this [first
environmental
remediation course]
is a good indication
of our future
cooperation."*

Sergey Cbesalov
V.P. EPG, Moscow
Office

Course Agenda:

Week 1: Washington, DC

Overviews on Government Programs with FSU in the area of Environmental Restoration and Waste Management:

- Department of Defense
- Environmental Protection Agency
- Commerce Department
- Nuclear Regulatory Agency
- Department of Energy-Program Offices
- Office of Environmental Restoration and Waste Management
- Agency for International Development

Non-Governmental Organizations:

- United States Environmental Training Institute
- National Academy of Sciences
- Maryland-Moscow
- Russian American Chamber of Commerce
- U.S./Russian Business Council
- Exchange Publications
- Environmental Technology Export Council

Week 2: Richland, Washington

Hanford Overview:

- Environmental restoration of soils and groundwater
- Decontamination and decommissioning of nuclear facilities
- Innovative technology development and deployment
- Tank waste remediation and management
- Risk assessment
- Environmental education
- Public involvement and the regulatory process

Environmental Restoration Course in Richland, Washington.

The workshop represented an extended technical exchange between scientists and engineers at a site level forum, and resulted in the recognition of opportunities for future collaboration. A second environmental restoration course will be held in the United States in August 1994.

Sergey Chesalov (sitting) and Igor Khodakovsky in the Hanford B Reactor. "Twenty years ago, I sat in the same chair at the first Soviet reactor... a place where my father worked" Chesalov said.

Tulane/Xavier

Under a grant from DOE, the Tulane/Xavier Center for Bioenvironmental Research has established a cooperative research program with The Institute of Radioecological Problems of the Academy of Sciences of Minsk, Belarus. In January 1994, a graduate student from the Institute of Radioecological Problems of the Academy of Sciences of Minsk, Belarus, was enrolled in a Ph.D. Mechanical engineering degree program at the Engineering School at Tulane University. He brought a Chernobyl data set, which he is currently applying to contaminant transport modeling codes.

Enhanced Data Transfer

Cooperative programs require rapid and reliable communications between U.S. and Russian institutes, scientists, and organizations. This program establishes electronic communications and computer support for messages and data transfer between scientists in both countries. The Russian electronic network, GLASNET, provides a capability for basic electronic mail with the U.S. through a gateway to INTERNET, as well as the capability within the FSU for binary file transfer.

Electronic Mail

DOE has established an electronic mail system with Russia. The network also provides DOE headquarters program managers with direct lines to their Russian counterparts. This access eases the management burden in terms of accountability, timeliness, and integration with U.S. DOE technology development efforts.

Russian Institutes with Electronic Mail

Institute of Physical Chemistry
-Adsorption Technology
-Separations: TRU Treatment

Russian Academy of Sciences
-JCCEM Contaminant Transport

Vernadsky Institute
-JCCEM Contaminant Transport

Khlopin Radium Institute
-JCCEM Separations Project
-Laser Evaporation Techniques

Institute of Chemical Technology
-Plasma Furnace Vitrification of TRU wastes
-Separations: Crown Ethers

Institute of Radioecologic Problems
-Scientists Exchange

Ukrainian Academy of Agrarian Science
-Befito Biomass Remediation

Tomsk-7
-Radiochemical Processing Safety

St. Petersburg Mining Institute
-JCCEM Contaminant Transport

Mayak Production Association
-JCCEM Contaminant Transport
-JCCEM Vitrification
-Plasma Furnace Vitrification of TRU Wastes

Moscow State University
-JCCEM Contaminant Transport

Institute of Spectroscopy
-Analytical Laboratory Network for Characterization and Monitoring

Boreskov Institute of Catalysis
-Applications of Catalysts to Treatment of Mixed Waste Off-Gases

Energopool
-Electrokinetic Extraction

Sun Microsystems Workstations

DOE, in partnership with Sun Microsystems, has provided Russian scientists with the hardware and software capability to collect, display, and analyze hazardous and radioactive contamination, and to identify appropriate cleanup technologies from the U.S. and other countries. The first system was delivered to Russia in August and is located at the Mayak Production Association in Chelyabinsk, Russia. This network enables continuous information flow concerning FSU science in general, and specific data regarding contaminant transport and health effects. EM is investigating locations for establishing additional workstations at other key FSU locations.

DOE/SUN Microsystems Enhanced Communication.

U.S. Russia Industry Partnership

First International Environmental Technology and Business Action Conference

In partnership with U.S. industry, Russian Ministries, and DOE, the Environmental Planning Group is organizing the First International Environmental Technology and Business Action Conference. The Conference will be held in Moscow, Russia in September 1994. The objectives are to promote international cooperation, information exchange and identify technical solutions to common U.S.-Russian environmental problems.

Red Square.

- Matches technologies with industrial and government needs.
- Commercializes faster, better, cheaper, safer technologies that can reduce remediation cost.
- Meets U.S. Government policy objectives by fostering political/economic reform and stability in the FSU.
- Creates revenue-generating commercial ventures that utilize U.S.-Russian government R&D resources.

Conference Activities

- Plenary session
- Table top displays
- Field visits
- Short-course seminars:
 - Telecommunications systems
 - Business registration
 - Government and private financing
 - Real estate
 - Business insurance
- Case studies of successful U.S.-Russian business ventures.
- Poster session
- Invited Russian technologies
- Banking
- Industrial espionage
- Taxes
- Business plans

Key conference participants will include: U.S. investors in Russian technology, Russians needing environmental technology, U.S. companies with environmental products and services, Russian technology developers, and facilitators (bankers, legal support, interpreters, international funding sources).

The Conference organizer, Environmental Planning Group, is currently seeking support in the form of conference cosponsorship. This commitment could include providing session chairs or invited speakers, giving paper presentations/demonstrations, or the designation of one or more staff to assist in the coordination of the conference. The firm of Steptoe & Johnson has agreed to cosponsor the Conference. Steptoe & Johnson, the leading U.S. law firm in Russia specializing in intellectual property rights, will serve as a facilitator for U.S. companies wanting to enter into contract negotiations with prospective Russian partners.

Environmental Management Center

In partnership with U.S. industry, Russian Ministries, and the DOE, the Environmental Planning Group is investigating the feasibility of establishing an Environmental Management Center in Moscow, Russia. The Center would be used to facilitate communications and technology transfer between U.S. and Russian organizations working on environmental restoration and waste management

EM Center Objectives

- Assist in the identification of Environmental Management-Related technologies.
- Track progress of EM-Sponsored Russian Technology Development.
- Meet U.S. Government policy objectives by fostering political/economic reform and stability in the former Soviet Union.
- Facilitate technology transfer between U.S. and Russian organizations working on EM activities.
- Provide support services:
 - legal
 - international communication
 - translation and interpreting
 - business support
- Central location for technical information.
- Self-sustaining after 2-year start-up period.
- Access to a shipping & receiving service (e.g. Federal Express).
- Access to electronic databases (e.g. Chemical Abstracts).

activities. It is envisioned that the Center will be self-sustaining after a two-year start-up period, i.e. the Center will be run for profit and will not require U.S. or Russian government support.

American Business Centers

The "Freedom for Russian and Emerging Democracies and Open Markets Support Act" (FSA) of 1992 calls for the establishment of environmental and agribusiness American Business Centers (ABC) in the FSU. The FSA authorizes a total of \$410 million for economic assistance, and \$12 million targeted directly for the establishment of the ABCs. The ABCs focus on establishing commercial partnerships for U.S. industry. Section 301 (b)(1) of the FSA states:

environmental business centers should be established in the states which offer promising market opportunities for U.S. environmental goods and services and the Far East of the FSU. The Centers shall emphasize small and medium-sized business facilitation; offer office space and business facilities, and market analysis services on the user-free basis; centers will serve as repositories of commercial, legal, technical and environmental information.

Locations of the centers are shown in the figure below.

American Business Centers.

Russian American Center for Contaminant Transport Studies

In addition to the Centers located within the FSU, LBL established the Russian American Center. While this Center's primary focus is joint research in the area of contaminant transport modeling, the Center provides additional services to both public and private sectors. The Center assists U.S. companies developing business in Russia, and provides expert U.S. and Russian resources for assessment of environmental issues related to their business developments. Examples of assistance are the assessment of petroleum resource contamination or forest management in contaminated zones.

Future Actions/Conclusion

The 12th Joint Committee Meeting, operating under the PUAE Agreement, will be held in the Spring of 1994. The 4th meeting of the JCCEM will be held in Moscow, in September 1994. DOE and MINATOM will continue to confirm their commitment to implementing the MOC, and the existing programs will be continued and enhanced in the area of contaminant transport modeling and separations technologies. It is vital that Russian technologies applicable to DOE's mission be identified and tested. Future actions include the following:

- Russian-developed Cobalt Dicarbolide will be tested at INEL to assess its use at U.S. sites.
- The vitrification exchange will be expanded to include a technical exchange workshop to be held in the U.S.
- Scientists will be placed at the Russian-American Center for Contaminant Transport Studies in Berkeley, California, to pursue cooperative efforts in contaminant transport modeling.
- DOE will seek to secure support for the Environmental Management Center.
- The First International Environmental Technology and Business Action conference will be held in Moscow in September 1994.

Without assistance funding, DOE activities with the FSU have been limited to those areas that specifically address the domestic cleanup mission. Thus, DOE's focus is on fostering Russian technology development and transfer that address the EM mission. DOE is also starting to capitalize on the data sets that are available from a series of unfortunate accidents that occurred in the FSU; this data will support efforts to validate U.S. models and codes needed to conduct performance assessments.

Given the resources and the mandate, DOE can have substantial impacts in other areas as well. DOE has technologies and scientists that could actively support site characterization efforts at Semipalitinsk, the nuclear weapons test site in Kazakhstan. The DOE resources spent buying FSU-produced plutonium could be used by the Russians to demonstrate U.S. technologies at Chelyabinsk-65. Using the DOE model, expansion of technology development efforts could fulfill administration desires to stabilize the Russian scientific base. Valuable environ-

mental management expertise could be used to conduct environmental assessments at former defense facilities in Estonia and other FSU countries. DOE has demonstrated technologies for the cleanup of soils and groundwater contaminated with petroleum products; these technologies perform significantly better than industry standards and could have broad application in the remediation of pipelines, refineries, and petroleum distribution centers in the FSU. DOE has also demonstrated technologies for the destruction of biological and chemical warfare agents. These are a few examples to consider regarding DOE's ability to meet Administration objectives in the FSU.

"Our future depends on decisions which we are making today, and that's the future of our children. So, I can say only... It's a long way to go. Let's walk hand in hand. Really. The time is right for that".

Alexander A. Pekk
Russian Academy of Sciences

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