APPENDIX G
IMPLEMENTING ARRANGEMENT #1
OF
THE U.S. DEPARTMENT OF ENERGY / RUSSIAN ACADEMY OF SCIENCES
MEMORANDUM OF UNDERSTANDING

THE INTERACTION OF ACTINIDES AND FISSION PRODUCTS WITH ENVIRONMENTAL MATRICES

Background:
Migration properties of radionuclides have been studied in the Institutes of the Russian Academy of Sciences during the past 30 years. Radiochemistry labs participated in the Government programs on remediation of contaminated regions of Russia such as the Chernobyl zone, industrial zones of PA "Mayak" and Krasnoyarsk MCP. Under contracts with the International Science and Technology Center, researchers at these labs have carried out investigations of solubility, complexation and colloid formation of transuranic elements in natural waters and waters after hydrothermal leaching of solidified high-level radioactive wastes. It has been shown that the distribution of radionuclides between mobile and immobile forms and different groups of organic and inorganic compounds depends upon properties of the radionuclides, initial mobilized forms, and environmental conditions.

The concentration of mobilized actinides at the surface of exposed waste forms and the chemical speciation (i.e., specification of the oxidation state, chemical form, and physical state [surface precipitate, secondary mineral, or adsorbate]) during geologic transport are important uncertainties that are treated in a bounding fashion in current Yucca Mountain Program (YMP) analyses. Environmental analog data is one component, along with laboratory data and process modeling, of the approach used to reduce uncertainty and increase confidence in support of program determinations. The ability of process models to define limits of mobilized concentrations depends on the accuracy and completeness of thermochemical data available.

Objective:
The objective of this activity is the study of the properties of radionuclides and characteristic migration processes during laboratory and field experiments at Russia contaminated sites.

As part of efforts in Russia and the United States to manage their radioactive (civilian and defense) waste, spent reactor fuel and their radioactively contaminated sites, investigations are underway to characterize various locations to assess their long-term performance with respect to containment of long-lived radionuclides. To evaluate the impact of the radioactive constituents on the environment, geochemical modeling is used. A database of thermodynamic and solubility values of waste radionuclides is being developed. Limited data is currently available regarding the aqueous behavior of waste radionuclides at repository (elevated) temperatures or their solution/solid interactions. Experiments need to be conducted before geochemical modeling can

proceed. The data, because of its fundamental nature, is applicable to nuclear waste repositories worldwide (site independent) and specifically to the U.S. Yucca Mountain Project.

Benefit to DOE:
Increased understanding about the availablity of radionuclide thermochemical properties, in particular at elevated temperature will benefit DOE RW programs, particularly the Yucca Mountain Site Characterization Program. Data such as these impact repository performance modeling. The results of this interaction will contribute to the international database development effort and may support future uses of less conservatively bounded and more technically defensible models for radionuclide behavior.

Workscope:
Data needs will be evaluated through evaluation of limits in currently existing data, including compilations of existing Russian data and comparison to existing U.S. and international databases. Sensitivity studies will be performed to prioritize data and data accuracy needs. Available experimental facilities and techniques will be assessed and compared to the data needs. Data to be determined will be prioritized and detailed experimental plans will be developed.

Parameters to be determined will likely come from the following list:

1) Solubility of transuranic elements in ground waters in dependence of chemical composition (pH, Eh), temperature and pressure using undersaturation and oversaturation conditions;
2) Colloid formation using membrane fractionation method;
3) Complexation with inorganic and organic ligands including organic substances;
4) Redox speciation of actinides using membrane extraction method;
5) Sorption/desorption processes of radionuclides on various rocks of different degrees of weathering;
6) Kinetics and mechanisms of radionuclide migration in soils depending on environmental conditions. These experiments are performed by Russian radiochemists using the same core competencies, expertise, instrumentation and equipment existing at sister facilities in Russia. Data reviews are currently being conducted by personnel at U.S. research facilities.

Agreement, in principle, has been reached by both parties that work will focus on two areas of interest to the DOE:

- Understanding parameters from the above list that may result in a lower calculated maximum potential dose from the potential Yucca Mountain repository. Studies will focus on the elements of neptunium and technetium.
- Expanding the thermochemical database utilizing existing Russian data and increasing confidence in the database. Predictions regarding dominant solution and solid species will be made for a series of groundwater conditions. Experiments will be conducted and the results compared with the predictions.

Duration:
3 years total

Expected Results:
Fundamental data will be obtained on solubility, complexation and colloid formation of radionuclides in natural waters. Database development will be appropriate to assess radionuclide migration processes at various nuclear waste repositories, and in particularly at the Yucca Mountain, PA Mayak, Krasnoyarsk MCP and others.

Tasks:
1) Detailed Activity Planning
A more detailed definition of the goal, plans and specific studies is needed beyond this Appendix. As part of this planning, existing data, further data needs and experimental capabilities will be assessed and prioritized. Representatives from the RAS and other Russian organizations will develop this plan with cooperation from the U.S. representatives. The results of this task will provide a more detailed plan for activities, including:

- Further definition of the goals and products of the activity
- Description of available experimental facilities and techniques
- Prioritization of data needs
- Detailed plans for data acquisition and analysis

Product 1.1: Program Plan Document
Product 1.2: Data Needs Summary and Prioritization Report
Product 1.3: Data Acquisition and Analysis Plan(s)
Duration: 6 months

2) Assembly and Analysis of Existing Data
Assembly and analysis of existing Russian information base as applicable to the goals of this study will be performed. This data must be organized into a useable format (such as the GEMBOCHS database used by many international repository programs, including the YMP). Because historical data has been acquired under a wide variety of conditions, acquisition documentation should be provided where available.

Evaluation of existing data will include sensitivity studies to evaluate the variation of speciation with various parameters (T, [CO_2], pH, Eh). Important "missing" data will be identified and a plan developed to determine the needed values. High priority data with a high degree of uncertainty will be redetermined as necessary.

Product 2.1: Existing Data Summary Report(s)
Duration: 18 months

3) Laboratory Studies

Laboratory analyses will be conducted to provide actinide properties in various environments. These initial studies will be planned in Task 1. Additional planning guidance will come from the Actinide Workshop scheduled for May 2000 in Moscow.

Product 3.1: Sample Acquisition and Analysis Data Report(s)
Duration: 30 months

4) Publication and Example Applications

To make the results most useful to the U.S.. Russian and international repository and site remediation programs, it is desirable to publish the results in appropriate venues. Publication in U.S.. Russian and international journals should be considered. The possibility of an arrangement for review and publication with the OECD-NEA should be explored, as NEA data is directly useable by national programs.

Product: Publication of Results in Appropriate Venues
Duration: 18 months

Effort and Schedule:

An initial estimate of the schedule of Tasks is provided here. Detailed plans for the remaining work will be developed in Task I

Task	Year 1				Year 2				Year 3			
1) Detailed Activity Planning												
2) Assembly of Existing Data												
3) Laboratory Studies												
4) Publication and Example Applications												

Quarterly Product Schedule:

The project will be conducted over a 36 month period. Products and/or status reports as indicated in the table below will be prepared and submitted every three months. Deliverables are due by the 10"' of each relevant month. Products and status reports will be delivered to the U.S. investigator(s) for review and acceptance.

Quarter	Deliverable	Title	Due Date (from start)
1	Product 1.1	Program Plan Document	3 months
2	Product 1.2	Data Needs Summary and Prioritization Report	6 months
	Product 1.3	Data Acquisition and Analysis Plan(s)	6 months
3	Status Report	Progress on Tasks 2 and 3	9 months
4	Status Report	Progress on Tasks 2 and 3	12 months
5	Status Report	Progress on Tasks 2 and 3	15 months
6	Product 2.1	Existing Data Summary Report(s)	18 months
7	Status Report	Progress on Task 3	2 1 months
8	Status Report	Progress on Task 3	24 months
9	Status Report	Progress on Tasks 3 and 4	27 months
10	Status Report	Progress on Tasks 3 and 4	30 months
11	Status Report	Progress on Tasks 3 and 4	33 months
12	Product 3.1	Sample Acquisition and Analysis Data Report(s)	3 6 months
	Product 4.1	Publication of Results in Appropriate Venues	36 months

Personnel:
Appropriate personnel from the Russian Academy of Sciences' Institutes will be identified during the detailed planning process.

Principal Investigators:
For DOE: Dr. Cynthia E.A.Palmer, Lawrence Liver-more National Laboratory
For RAS: Academician Boris Myasoedov, V.I. Vernadsky Lnstitute of Geochemistry and Analytical Chemistry

Proposed Period of Performance and Payment Schedule
This project will be conducted over a 36 month period. The beginning of the contract is anticipated to be October 1, 2000. The completion of the project is September 30, 2003. Agreement has been reached by both parties that the funding will be approximately $100,000 USD per year for three years. The funding level will be reviewed each year. Final resolution of the detailed work plan, work schedule and payment plan will be negotiated on behalf of the DOE by the ISTC or other appropriate vehicle and the RAS.

The responsibility of the parties for the violation of the terms of the Contract shall be determined by the Joint Coordinating Committee for Science and Technology.

Signed:

Lake Barrett
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
18.05.2000

Dr. Boris Myasoedov
Deputy Secretary General for Science
Russian Academy of Sciences
18.05.2000