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

ACTINIDE SPECIATION IN THE ENVIRONMENT TO SUPPORT SAFETY ASSESSMENT OF GEOLOGIC REPOSITORIES AND FOR THE REMEDIATION OF CONTAMINATED SITES

Background:
Several sites exist in Russia for observing actinide behavior in the natural environment. These include:

A) Deep borehole injection of liquid HLW/MLW/LLW near Tomsk and Krasnoyarsk. While the actinide content of the waste is low, these sites are of particular interest because of the large inventory (IO" Ci), long time (decades) and migration path (10' – 1 0^3 m) in deep geologic media.

B) Near-surface contamination including actinides near Mayak in soil, lake and river sediments.

C) Uranium ore bodies as natural analogs

There have been prior studies of the near-surface contamination sites that may provide a valuable basis for assembling actinide analog data. The borehole injection sites have been monitored and studied by RAS and Minatom organizations throughout their use, and a collaborative study of these sites has recently been approved by the European Union involving both RAS and Minatom organizations.

Methods of actinide speciation have been developed at Vernadsky Institute of Geochemistry and Analytical Chemistry Russian Academy of Sciences (GEOCHi RAS) for 20 years. Under contracts with International Science and Technology Center and Lawrence Berkeley National Laboratory, investigations of actinide occurrence forms have been carried out in some contaminated regions of Russia such as the Chernobyl zone, industrial zones of PA "Mayak" and Krasnoyarsk MCP. Fundamental data have been obtained on the distribution of actinides between groups and fractious of the organic matter for near-surface contamination relevant to site remediation. It was shown that humic acids and nonspecific low-molecular-weight organic acids contribute significantly to formation of the mobile forms of radionuclides.

Objectives:
The objective of this activity is the study of actinide behavior in the environment at contaminated sites in Russia. This includes observation of actinide speciation, transport properties and processes in deep geologic injection sites and in contaminated near-surface aquatic and terrestrial ecosystems. Thermodynamic and kinetic parameters important to geologic repository safety assessment and contaminated site remediation will be determined.

Actinide speciation and transport data from Russian anthropogenic analog sites can provide valuable corroboration of transport data, calculations and transport models used in the safety assessment of geologic repository concepts such as the U.S. Yucca Mountain Project and a proposed Russian repository. 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 YMP analyses. Environmental analog data is one component, along with laboratory data and process modeling, of the approach to developing more accurate representations with narrower bounds. Long-lived fission products, such as Tc, are potentially of interest.

Actinide speciation at Russian anthropogenic analog sites can assist DOE and Russian site remediation programs. The availability of speciation information of the contaminants plays a primary role, as their response to remediation technologies will vary as the speciation varies. This will be particularly true for sites contaminated with actinides (U, Np, and Pu) that can exist in several different oxidation states in the environment. Once the speciation has been characterized, the remediation technology can be devised with the specific chemical and physical form of the actinide contaminant in mind. This will lead to more efficient and less drastic remediation measures.

Benefits to DOE:
Increased understanding of the behavior of actinides in the environment will benefit DOE RW programs, particularly the Yucca Mountain Site Characterization Program. Actinide concentrations used by the Program's Performance Assessment calculations are currently given wide bounds to account for uncertainty in the speciation and controlling processes. 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:
The potential sites in Russia for the study of actinide speciation and transport in the environment will be evaluated and specific sites selected. Data acquisition will be planned and conducted in parallel with development of conceptual models for actinide behavior. The models will suggest information needs for the field studies, and the field studies will provide data for the models. Applications will be investigated and published for the resulting data and models.

It is proposed to collect solid and liquid samples from aquatic and terrestrial ecosystems near Ozersk, Krasnoyarsk and Tomsk and to analyze them using techniques elaborated in GEOCHi RAS speciation procedure. The following parameters are planned to be determined:

Water samples:

1) Oxidation states and concentration of actinides in solution
2) Concentration and properties of colloidal species including:
   The charge and size of suspended particles incorporating actinides
   Complexation with dissolved organic acids
3) Bulk water chemistry to allow modeling of actinide behavior for comparison to observations.

Solid samples:

1) Solid phases controlling actinide solubility, precipitation and oxidation state
2) Geochemical forms of mobile actinides
3) Distribution of actinides between groups of organic matter
4) Oxidation states of actinides leaching by water, Tamm solution and mineral acids

Total Project Duration:
3 years total

Expected Results:
Data will be obtained on actinide speciation in natural surface, deep geologic ground waters as well as in bottom sediments, soils and in suspension, depending on chemical and mineralogical composition of samples. These data will be the base for developing a mathematical model for prediction of the behavior of actinides in the environment useful to geologic repository programs and site remediation programs in both Russia and the U.S.

Tasks:
1) Initial Planning and Site Screening
A more detailed definition of the goal, plans and specific studies is needed beyond this Appendix. As part of this planning, the variety of potential analog study sites and data acquisition activities will be assessed and prioritized. Representatives from the RAS and other Russian organizations will develop this plan with cooperation from the US representatives. The results of this task will be more detailed plans for activities, including:

- Further definition of the goals and products of the activity
- Description of available analog study sites
- Prioritization of site studies (lnitial and Final)
- Detailed plans for initial data acquisition and analysis at selected sites (Initial and Final)

Product 1.1: Program Plan Document
Product 1.2: Candidate Site Summary and Prioritization Report
Product 1.3: Initial Site Specific Data Acquisition and Analysis Plan(s)
Product I .4: Final Site Selection and Data Acquisition and Analysis Plan(s)
Task Duration: 9 months

2) Assembly of Existing Data

Assembly and evaluation 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. Because historical data has been acquired under a wide variety of conditions, acquisition documentation should be provided where available.

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

3) Initial Field Studies

Acquisition of samples and laboratory analyses will be performed to provide actinide speciation and transport properties in the natural environment. These initial studies will be planned in Task 1.

Product 3.1: Sample Acquisition and Analysis Data Report(s)
Task Duration: 18 months

4) Conceptual Model Development

In parallel with data gathering, conceptual models of actinide behavior in the natural environment are needed. The models will include current understanding of controlling features and processes. The models will help define the data needs from the field studies in Tasks 3 and 5 and will provide a framework for use of the data acquired.

Product 4.1: Initial Conceptual Models of Actinide Behavior in Natural Environments
Product 4.2: Data Needs from Field Studies
Product 4.3: Final Conceptual Models of Actinide Behavior in Natural Environments
Task Duration: 24 months

5) Final Field Studies

Following model development and initial data acquisition, the models and new data should be used to define further data needs based on new findings from the initial work or remaining uncertainties in our understanding of actinide behavior in the natural environment. Further sample acquisition and analysis will be performed as needed.

Product 5.1: Sample Acquisition and Analysis Data Report(s)
Task Duration: 18 months

6) 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. Applicability for me in support of YMP performance assessment will be addressed.

Product 6.1: Publication of Results in Appropriate Venues
Task Duration: 18 months

Effort and Schedule:
An initial estimate of the schedule of is provided here. Detailed plans for the remaining work will be developed in Task 1.

Task	Year 1				Year 2				Year 3			
1) Initial Planning and Site Screening												
2) Assembly of Existing Data												
3) Initial Field Studies												
4) Conceptual Model Development												
5) Final Field Studies												
6) 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 10th of each relevant month. Products and status reports will be delivered to the U.S. investigators for review and acceptance.

Quarter	Deliverable	Title	Due Date (from start)
1	Product I. 1	Program Plan Document	3 months
2	Product I .2	Candidate Site Summary and Prioritization Report	6 months
	Product 1.3	Initial Site Specific Data Acquisition and Analysis Plan(s)	6 months
3	Status Report	Progress on Tasks 2, 3 and 4	9 months
4	Product 4.1	Initial Conceptual Models of Actinide Behavior in Natural Environments	12 months
5	Product 4.2	Data Needs from Field Studies	15 months
6	Product 1.4	Final Site Selection and Data Acquisition and Analysis Plan(s)	18 months
	Product 2.1	Existing Data Summary Report(s)	18 months
7	Status Report	Progress on Tasks 3, 4 and 5	21 months
8	Product 3.1	Sample Acquisition and Analysis Data Report(s)	24 months
9	Status Report	Progress on Tasks 4, 5 and 6	27 months
10	Product 4.3	Final Conceptual Models of Actinide Behavior in Natural Environments	30 months
11	Status Report	Progress on Tasks 5 and 6	33 months
12	Product 5.1	Sample Acquisition and Analysis Data Report(s)	36 months
	Product 6.1	Publication of Results in Appropriate Venues	36 months

Personnel:
Researchers from the Institute of Geochemistry and Analytical Chemistry, the Research Production Association - Radium Institute, other Russian organizations as appropriate, and some DOE facilities

Principal Investigators:

For DOE: William Halsey, Lawrence Livermore National Laboratory
Ardyth Simmons, Lawrence Berkeley National Laboratory

For RAS: Academician Boris Myasoedov, Institute of Geochemistry and Analytical Chemistry RAS

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