OAK RIDGE NATIONAL LABORATORY
OPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX X
OAK RIDGE, TENNESSEE 37831

November 5, 1987

Dr. D. J. Brooks
Geotechnical Branch
Office of Nuclear Material
Safety and Safeguards
U.S. Nuclear Regulatory Commission
Room 623-SS
Washington, D.C. 20555

Dear Dave:

Enclosed is the October 1987 progress report for B0287, Technical Assistance in Geochemistry.

Sincerely,

A. D. Kelmers

A. D. Kelmers, Project Manager
B0287 Technical Assistance in Geochemistry
Chemical Technology Division
Bldg. 4500N, MS-268; FTS 624-6870

ADK:ech

cc/encl: Office of the Director, NMSS (Attn: Program Support Branch)
Division Director, Division of High-Level Waste Management, NMSS, NRC (2)
R. L. Ballard, Chief, Technical Review Branch, NMSS, NRC
J. W. Bradbury, Technical Review Branch, NMSS, NRC
G. F. Birchard, Waste Management Branch, RES, NRC
A. P. Malinauskas, Director, NRC Programs, ORNL

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WM Project: WM-10, 11, 16
PDR w/encl
(Return to WM, 623-SS)

WM Record File: B0287
LPDR w/encl

bcc w/encl: R. M. Gove, 4500N, MS-235
G. K. Jacobs, 1505, MS-038
R. E. Meyer, 4500N, MS-201
V. S. Tripathi, 1505, MS-036
K. L. Von Damm, 1505, 036

bcc wo/encl: J. T. Bell, 4500N, MS-268
J. R. Hightower, 4501, MS-223

11/03/87

PROGRESS REPORT FOR OCTOBER 1987

PROJECT TITLE: Technical Assistance in Geochemistry (FIN No. B0287)

PROJECT STAFF: R. M. Gove, G. K. Jacobs, V. S. Tripathi, K. L. Von Damm, and G. T. Yeh

PROJECT MANAGER: A. D. Kelmers
Chemical Development Section
Chemical Technology Division
OAK RIDGE NATIONAL LABORATORY, operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.

ACTIVITY NUMBER: ORNL # 41 88 54 92 4 / NRC # 50 19 03 01

OBJECTIVE:

The objective of this project is to provide technical assistance to the NRC in the evaluation of geochemical information pertinent to the candidate high-level-waste geologic repository sites. The project emphasizes the collection and review of key information to provide input to the NRC analysis of technical issues regarding the geochemical aspects of geologic isolation of high-level-waste, and review of site selection and repository licensing documentation.

TECHNICAL HIGHLIGHTS:

As requested by the NRC Project Manager, the following documents are under review and evaluation and the analysis will be summarized in Letter Reports. G. K. Jacobs and V. S. Tripathi are reviewing the 129-iodine data from BWIP and the draft document on numerical modeling of groundwater flow systems. K. L. Von Damm is reviewing the draft report on redox conditions. D. C. Kocher is reviewing the draft document on uncertainties in the performance of repositories. A. D. Kelmers has reviewed the draft report on probabilities of geochemical processes; the analysis is reported in LR-287-72, enclosed. S. D. Clinton is analyzing the suite of reports by Pigford and Chambre' on radionuclide diffusion through failed waste packages.

A copy of the draft Geochemistry section of draft Chapter 8 of the Site Characterization Plan for Yucca Mountain was obtained at the DOE briefing in Washington. The document is currently being examined by the project staff.

MEETINGS AND TRIPS:

A. D. Kelmers attended a DOE briefing on the organization of Chapter 8 of the Site Characterization Plans in Washington, D.D., on October 7-9, 1987.

REPORTS AND PUBLICATIONS:

A. D. Kelmers, Letter Report LR-287-72, October 23, 1987: Review of draft Chapter 10, "Geochemical Processes", by H. D. Holland, C. Feakes, M. Siegel, and S. Faith, of draft report Techniques for Determining Probabilities of Events and Processes Affecting the Performance of Geologic Repositories: Volume 1--Literature Review, R. G. Hunter and C. J. Mann, eds., draft NUREG/CR-3964, September 1987.

PROBLEM AREAS:

None

COST/BUDGET REPORT:

Expenditures for October were not available at this time. A detailed cost/budget report will be forwarded under separate cover.

LR-287-72
10/23/87

LETTER REPORT

TITLE: Review of draft Chapter 10, "Geochemical Processes", by H. D. Holland, C. Feakes, M. Siegel, and S. Faith, of draft report Techniques for Determining Probabilities of Events and Processes Affecting the Performance of Geologic Repositories: Volume 1--Literature Review, R. G. Hunter and C. J. Mann, editors, draft NUREG/CR-3964, September 1987

AUTHOR: A. D. Kelmers

PROJECT TITLE: Technical Assistance in Geochemistry (FIN B0287)

PROJECT MANAGER: A. D. Kelmers, Chemical Development Section, Chemical Technology Division, OAK RIDGE NATIONAL LABORATORY, operated by MARTIN MARIETTA ENERGY SYSTEMS, INC.

ACTIVITY NUMBER: ORNL # 41 88 54 92 4 / NRC # 50 19 03 01

SUMMARY

The purpose of the report, as stated on p. 1 of the Executive Summary, is "... a literature review that assembles and discusses existing techniques that can assign or can be helpful in assigning probabilities to events and processes ...." It is also stated on p. 1 that "Each chapter concludes with a brief description of a technique that could be used immediately for assigning probabilities to the events or processes of concern." The review of Chapter 10, Geochemical Processes, did not clearly show that these intentions were met in the draft chapter. Uncertainties in geochemical information were reviewed, but existing techniques for assigning probabilities to values for geochemical data or processes were only marginally discussed. In part, this may be due to the limited applicability, as well as the current limited application, of probabilistic methodology to the geochemical processes of importance to repository assessment. The section Geochemistry, p. 28 of the Executive Summary of the draft report, was left blank. In the Summary and Conclusions section of the draft Chapter 10, p. 10-39, the following statements are made: "... probabilistic techniques are apt to be useful in predicting at least some of the parameters that are important for assessing the elimination and/or retardation of radionuclides .... There is usually, however, not enough detailed information regarding the mineralogy, chemistry, texture, and structure of rocks between repositories and the surface to permit precise forecasts to be made of the interaction of radionuclides in contaminated groundwaters with the rock units along their flow path. The problem is exacerbated by a current lack of good data for some of the radionuclides." These statements can, perhaps, be interpreted as the author's acknowledgment that probabilistic

approaches may be of limited usefulness in predicting the likelihood of occurrence of geochemically-controlled events in conducting repository assessments and in demonstrating expected repository compliance with regulatory requirements.

REVIEW

Draft chapter 10, Geochemical Processes, is essentially divided into three sections. The first, pp. 10-2 through 10-22, contains an introduction and discusses box models for geochemical systems, an environmental transport model, and geostatistical methods. The second section, pp. 10-22 through 10-39, is a review of some of the types of geochemical information available for repository assessment analyses and a discussion of the uncertainties associated with these data. Statistical techniques for evaluation of waste package performance and radionuclide sorption are also discussed. Finally, pp. 10-39 through 10-40 contain a brief chapter summary and conclusions.

Probabilistic methodology has been developed for and applied to many engineering problems which involve random events. A simple example would be estimation of the probability of a bolt failure in a piece of machinery. Through laboratory testing and field experience, a statistically-valid data base would be developed to support the probabilistic analysis. Many of the geochemical processes important to repository assessment are not random but are continuous, however, and, in addition, the data base available to support a probabilistic analysis may be restricted and of poor statistical precision. For example, sorption of most radionuclides is certain to occur along the release pathway, i.e., the probability of sorption is 1 and the issue for analysis then becomes one of addressing the probability that a given sorption value lies within some probability bound. Probability analysis can also be based on theoretical models of behavior, but theoretical treatment of geochemical processes such as sorption in geologic systems is beyond modeling capability at this time. Considerations such as these may help explain the general absence or minor role of probabilistic methodology in geochemical science.

Box models employ reservoirs and flow paths to describe the movement of materials. The discussion of box models in draft Chapter 10 examines a Sandia-developed environmental transport model but does not address the probability of these transport events. Geostatistics are also discussed in a number of pages. Geostatistical techniques have been applied to problems involving ore deposits where a substantial data base has been developed. References to statistical determination of rock physical properties are also cited. References to the application of statistical techniques to repository-related problems are included, however, these primarily address issues of mineral content in various rock units rather than radionuclide release studies.

The extended discussion of uncertainties in geochemical information such as the source term, radionuclide solubility, radionuclide retardation, etc. is

interesting and seems cogent. A theme which runs through the discussion, however, is the paucity of data for many of the important parameters, especially the chemistry of the actinides in rock/groundwater environments. A subsection is included on the application of statistical techniques to radionuclide sorption. Only two references are cited, both of which are about 10 years old, i.e., they were written before the collection of repository geochemical information. The text does not show any important applications of statistical techniques to the analysis of repository geochemical data; it seems likely none exists. Probably, the main stumbling blocks to the application of such techniques are the poorly-understood and complex chemistry of some of the important processes such as sorption or retardation, as well as the limited data base.

The Summary and Conclusion section to the draft Chapter 10 is less than one page long. No techniques which can be used immediately for assessing probabilities of geochemical events or processes are presented. The conclusions seem to indicate that the authors feel probabilistic methodology might have some application in the future after current deficiencies in the understanding of processes and the inadequate data base are alleviated.

PDR-1
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WM-11(2)
WM-16(2)

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WM-RES
WM Record File
B0287
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WM Project 10,11,16
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Distribution:
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