Department of Energy
Washington, DC 20585

June 7, 1994

Susan: Thanks. Please enter. Pauline Brooks 6/10/94

Mr. Joseph J. Holonich, Chief
High-Level Waste and Uranium
Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Holonich:

By letter dated January 19, 1994 (Reamer to Shelor), the U.S. Nuclear Regulatory Commission transmitted to the U.S. Department of Energy (DOE) its review of Study Plan 8.3.1.3.6.2, "Diffusion." The U.S. Nuclear Regulatory Commission raised one question (referenced as "Question 1") relative to its review (see Enclosure 1). Enclosure 2 of this letter contains the formal DOE response to the U.S. Nuclear Regulatory Commission Question 1.

The question raised by the U.S. Nuclear Regulatory Commission related to the characterization of the advective contribution to transport of rapidly sorbed radionuclides during thin tuff wafer experiments. The DOE response includes a simple calculation that demonstrates that advective transport is a negligible contribution compared to diffusive transport in these experiments. Consequently, the effect does not have to be "compensated for" in the analysis of the experiments.

If you have any questions, please contact Ms. Sheila Long of my office at (202) 586-1447.

Sincerely,

Dwight E. Shelor
Associate Director for
Systems and Compliance
Office of Civilian Radioactive
Waste Management

2 Enclosures:

1. Ltr, 1/19/94, Reamer to Shelor, w/encl
2. Response to NRC Question 1

NH03 1/1
102.8
WM-11

cc: w\enclosures
R. Nelson, YMSCO
T. J. Hickey, Nevada Legislative Committee
R. Loux, State of Nevada
D. Bechtel, Las Vegas, NV
Eureka County, NV
Lander County, Battle Mountain, NV
P. Niedzielski-Eichner, Nye County, NV
W. Offutt, Nye County, NV
L. Bradshaw, Nye County, NV
C. Schank, Churchill County, NV
F. Mariani, White Pine County, NV
V. Poe, Mineral County, NV
J. Pitts, Lincoln County, NV
J. Hayes, Esmeralda County, NV
B. Mettam, Inyo County, CA
M. Delligatti, NRC

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

JAN 32 9 13 AM '00 JAN 19 1994

Mr. Dwight E. Shelor, Associate Director for
Systems and Compliance
Office of Civilian Radioactive Waste Management
U.S. Department of Energy, RW 30
1000 Independence Avenue
Washington, DC 20585

Dear Mr. Shelor:

SUBJECT: REVIEW OF U.S. DEPARTMENT OF ENERGY (DOE) STUDY PLAN "DIFFUSION"

On August 13, 1993, DOE transmitted the study plan, "Diffusion" (Study Plan 8.3.1.3.6.2) to the U.S. Nuclear Regulatory Commission for review and comment. NRC has completed its review of this document using the Review Plan for NRC Staff Review of DOE Study Plans, Revision 2 (March 10, 1993). The material submitted in the study plan was considered to be consistent, to the extent possible at this time, with the revised NRC-DOE "Level of Detail Agreement and Review Process for Study Plans" (Shelor to Holonich, March 22, 1993).

A major purpose of the review is to identify concerns with studies, tests, or analyses that, if started, could cause significant and irreparable adverse effects on the site, the site characterization program, or the eventual usability of the data for licensing. Such concerns would constitute objections, as that term has been used in earlier NRC staff reviews of DOE's documents related to site characterization (Consultation Draft Site Characterization Plan and the Site Characterization Plan for the Yucca Mountain site). It does not appear that the conduct of the activities described in this study plan will have adverse impacts on repository performance and the review of this study plan identified no objections with any of the activities proposed.

As part of its study plan review, the NRC staff determines whether or not detailed comments or questions are warranted. The NRC staff's review of the subject study plan has resulted in the identification of one question. The enclosed question will be tracked by the NRC staff as an open item similar to SCA comments and questions.

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ENCLOSURE 1

If you have any questions concerning this letter or the enclosure, please contact Charlotte Abrams (301) 504-3403 of my staff.

Sincerely,

C. William Reamer, Acting Director
Repository Licensing and Quality Assurance
Project Directorate
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosures: As stated

cc: R. Loux, State of Nevada
T. J. Hickey, Nevada Legislative Committee
J. Meder, Nevada Legislative Counsel Bureau
R. Nelson, YMPO
M. Murphy, Nye County, NV
M. Baughman, Lincoln County, NV
D. Bechtel, Clark County, NV
D. Weigel, GAO
P. Niedzielski-Eichner, Nye County, NV
B. Mettam, Inyo County, CA
V. Poe, Mineral County, NV
F. Sperry, White Pine County, NV
R. Williams, Lander County, NV
L. Fiorenzi, Eureka County, NV
J. Hoffman, Esmeralda County, NV
C. Schank, Churchill County, NV
L. Bradshaw, Nye County, NV

ENCLOSURE

Study Plan 8.3.1.3.6.2 Diffusion

QUESTION 1

For the kinetic studies, how will pure diffusion of rapidly sorbed radionuclides be demonstrated in a thin tuff wafer immersed in a stirred solution?

BASIS

Section 3.2.1 Test Methods describes the experimental set-up for kinetic studies for rapidly sorbed radionuclides where a thin tuff wafer is suspended from a teflon thread in a stirred radionuclide-bearing solution.

Section 3.2.4 describes the analytical solution for a solute diffusing from a liquid solution into a plane sheet of material. This method assumes that "the concentration of tracer in the solution in contact with the sheet is always uniform...."

In order to assure the concentration of the tracer in the liquid solution is uniform, the solution is stirred.

However, advection in the stirred solution may produce advective transport in the tuff wafer due to the small pressure differences of fluid impinging the solid surface.

Consequently, transport by "diffusion" would be overestimated. Likewise, radionuclide retardation of matrix diffusion in fracture flow conditions would also be overestimated.

RECOMMENDATION

Describe how the advective contribution to transport in the tuff due to stirring will be eliminated or compensated for in these diffusion experiments.

U.S. DEPARTMENT OF ENERGY RESPONSE TO
U.S. NUCLEAR REGULATORY COMMISSION (NRC) QUESTION 1
ON STUDY PLAN 8.3.1.3.6.2 (DIFFUSION)

NRC Question 1

For the kinetic studies, how will pure diffusion of rapidly sorbed radionuclides be demonstrated in a thin tuff wafer immersed in a stirred solution?

DOE Response to Question 1

The advective contribution to transport in the tuff wafer experiments (due to stirring) is negligible. A very conservative calculation can illustrate this point. The stirring that takes place in these diffusion experiments is extremely mild and the flow of water is not turbulent.

A calculation can be made based simply on observing the experiment in progress and visually observing the increase in water level as a result of agitation. A tuff wafer with a radius of 2.5 cm and a thickness of 2 mm was suspended in a container that had a 150 g of aqueous solution. The container (with the wafer) was agitated at a rate of 4 rpm with a radius of revolution of 5 cm.

No increase was observed in the water level as a result of mixing; however, one could assume that the human eye, even when directed by graduations in the container, cannot detect fluctuations in the water level smaller than 0.25 cm. Based on this assumption, Darcy's Law (given in Equation 1) can be utilized to calculate the maximum penetration due to advection, where ρ is the water density, g is the acceleration due to gravity, and h is the hydraulic head.

$$U = - \frac{k\rho g}{\mu} \, grad \, h \qquad (1)$$

Assuming a permeability of $10^{-14}cm^2$, a porosity of 0.3, a viscosity of 0.01 g $cm^{-1}s^{-1}$, and a total experimental time of 8 weeks, the maximum penetration due to advection is 0.2 mm. Assuming a diffusion coefficient (through the tuff) of 5×10^{-7} cm2/s, the penetration due to diffusion is 15 mm. Consequently, advection results in a 1% error in the total movement observed.

It should be noted that the calculation that can be performed to show the exact magnitude of the effect is very difficult but is expected to result in the same conclusion (that the contribution of advection to the movement of the radionuclide through the tuff wafer is negligible).

It should also be noted that this is not the only type of experiment used to determine the diffusion through tuff (the tuff wafer experiment is the simplest and the most inexpensive). If discrepancies are observed between the results obtained in the wafer experiments and the other types of diffusion experiments (delineated in the study plan), this issue will be revisited.