

February 14, 2003

Joseph D. Ziegler, Acting Assistant Manager  
Office of Licensing and Regulatory Compliance  
U.S. Department of Energy  
Office of Repository Development  
P.O. Box 364629  
North Las Vegas, NV 89036-8629

SUBJECT: RADIONUCLIDE TRANSPORT (RT) AGREEMENT 2.05

Dear Mr. Ziegler:

In your letter dated September 20, 2002, the U.S. Department of Energy (DOE) enclosed a test plan entitled Test Plan For: Laboratory Sorption Measurements - SZ SITP-02-SZ-004 (Revision 01). The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed this information, with respect to RT Agreement 2.05, and the results of the staff's review are enclosed.

Performance assessments conducted by DOE and NRC have indicated that simulations of transport of radionuclides through the saturated alluvium south of Yucca Mountain are sensitive to the values of model transport parameters. This is one of several agreements related to the alluvium characterization activities in an effort to ensure adequate understanding and resolution of questions pertinent to this potentially risk significant barrier.

The enclosed test plan (Reimus, 2002a) provides a general description of experimental activities designed to support the DOE's Total System Performance Assessment by obtaining estimates of sorption and transport parameters for the saturated alluvium and by reducing their uncertainties in saturated zone models. The specific objectives identified in the test plan are (1) determination of radionuclide sorption and desorption parameters for use in performance assessment and process-level models and (2) determination of whether natural colloids can significantly facilitate the transport of strongly-sorbing actinides in the saturated alluvium south of Yucca Mountain.

In your cover letter you state that "...the enclosure to this letter provides a partial response to GEN 1.01(42) which refers to the alluvial characterization work discussed in agreements RT 2.01 through RT 2.09." The NRC considers that GEN 1.01(42) is complete as described in the letter on RT Agreements 2.03 and 2.04 from J. Schlueter to J. Ziegler on August 30, 2002."

Also, you note that the test plan provides a partial response to a NRC request for additional information on RT3.08, which refers to the use of microspheres as analogs for colloids. The staff accepts as a partial response the statement in the plan to continue testing the transport of microspheres as compared to natural colloids in alluvial material.

J. Ziegler

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As noted in the agreement, the staff provides three comments for DOE's consideration:

1. NRC staff recommend that the scope of work for lab sorption tests be expanded to include investigation of the effects of variations in pH and dissolved carbonate.
2. The importance of understanding colloid transport may extend beyond effects on highly sorbing nuclides such as Pu and Am.

Finally, Agreement RT.2.05 is considered complete. If there are any questions regarding this letter, please contact William Dam at 301-415-6710 or by e-mail at [wld@nrc.gov](mailto:wld@nrc.gov).

Sincerely,

***/RA/***

Janet R. Schlueter, Chief  
High-Level Waste Branch  
Division of Waste Management  
Office of Nuclear Material Safety  
and Safeguards

Attachment: NRC Review of DOE Letter Pertaining to RT 2.05.

cc: See attached distribution list

Letter to J. Ziegler from J. Schlueter dated February 14, 2003

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J. Ziegler

As noted in the agreement, the staff provides three comments for DOE's consideration:

1. NRC staff recommend that the scope of work for lab sorption tests be expanded to include investigation of the effects of variations in pH and dissolved carbonate.
2. The importance of understanding colloid transport may extend beyond effects on highly sorbing nuclides such as Pu and Am.

Finally, Agreement RT.2.05 is considered complete. If there are any questions regarding this letter, please contact William Dam at 301-415-6710 or by e-mail at wld@nrc.gov.

Sincerely,

**/RA/**

Janet R. Schlueter, Chief  
High-Level Waste Branch  
Division of Waste Management  
Office of Nuclear Material Safety  
and Safeguards

Attachment: NRC Review of DOE Letter Pertaining to USFIC.5.05 and RT 2.09.

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## **NRC Review of DOE Documents Pertaining to Key Technical Issue Agreement RT.2.05**

The U.S. Nuclear Regulatory Commission (NRC) goal of issue resolution during this interim pre-licensing period is to assure that the U.S. Department of Energy (DOE) has assembled enough information on a given issue for NRC to accept a licensing application for review. Resolution by the NRC staff during pre-licensing does not prevent anyone from raising any issue for NRC consideration during the licensing proceedings. Just as important, resolution by the NRC staff during pre-licensing does not prejudge what the NRC staff evaluation of that issue will be after its licensing review. Issues are resolved by the NRC staff during pre-licensing when the staff has no further questions or comments about how DOE is addressing an issue. Pertinent new information could raise new questions or comments on a previously resolved issue.

This enclosure addresses agreement RT.2.05, which was reached between NRC and DOE during the Radionuclide Transport Technical Exchange and Management Meeting<sup>1</sup> held in December 2000.

### **Wording of the Agreement**

RT.2.05 states: "Provide the laboratory testing plan for laboratory radionuclide transport studies. NRC will review the plan and provide comments, if any, for DOE's consideration. In support and preparation for the October/November 2000 Saturated Zone meeting, DOE provided work plans for the Alluvium Testing Complex and the Nye County Early Warning Drilling Program (FWP-SBD-99-002, Alluvial Tracer Testing Field Work Package, and FWP-SBD-99-001, Nye County Early Warning Drilling Program, Phase II and Alluvial Complex Drilling). DOE will provide test plans of the style of the Alcove 8 plan as they become available. The plan will be amended to include laboratory testing. In addition, the NRC On Site Representative attends DOE/Nye County planning meetings and is made aware of all plans and updates to plans as they are made."

### **NRC Review**

#### Background

Adequate characterization and understanding of the nature of the saturated zone at Yucca Mountain is important in evaluating the potential performance of the proposed repository. The saturated zone may act as both the primary conduit for the transport of radionuclides away from the proposed repository and as a natural barrier to that transport. Performance assessments conducted by the DOE and NRC have indicated that simulations of transport of radionuclides through the saturated alluvium south of Yucca Mountain are sensitive to the values of model transport parameters (e.g., retardation coefficient for Np-237, effective porosity of alluvium, and heterogeneity of alluvium hydraulic conductivity). Relative to the area in the immediate vicinity of the proposed repository, the saturated alluvium is little characterized. DOE has planned and is conducting several studies designed to improve saturated alluvium characterization prior to a potential license application. NRC staff initiated several agreements related to the alluvium

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<sup>1</sup>Reamer, C.W. "U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Radionuclide Transport (December 5-7, 2000)." Letter (December 12, 2000) to S. Brocum, DOE.

characterization activities in an effort to ensure adequate understanding and resolution of questions pertinent to this potentially risk significant barrier. In general, review and assessment of testing plans provides NRC with an opportunity to address important issues in a pre-licensing context and in time for the issues to be resolved during testing, helping to eliminate the need for additional questions after testing is completed. In this vein, NRC staff requested that DOE provide the laboratory transport testing plans as described in agreement RT.2.05.

#### Summary of the Information Provided by DOE

DOE transmitted by letter<sup>2</sup> in September 2002 a test plan entitled “Test Plan for: Laboratory Sorption Measurements – SZ” (Reimus, 2002a) to address agreement item RT.2.05. The letter states that the test plan addresses laboratory radionuclide sorption and transport investigations on saturated alluvium from Nye County Early Warning Drilling Program wells. The letter also states that the test plan covers additional laboratory testing added to provide information on some transport properties that would no longer be available from Alluvium Testing Complex cross-hole testing because of denial of required permits by the state of Nevada. Additional information provided in the letter indicates the test plan provides a partial response to agreement items GEN.1.01 (42) and RT.3.08.

GEN.1.01 (42) is a comment item resulting from review of the Supplemental Science and Performance Assessment (Bechtel, 2001) discussed at the Range of Thermal Operating Temperatures Technical Exchange and Management Meeting<sup>3</sup> held in September 2001. GEN.1.01 (42) states: “DOE is aware that much more transport relevant alluvium characterization needs to be done, so no specific comments are needed on the discussions of alluvium Np and U sorption coefficients, bulk density, and effective porosity. Alluvium characterization is the subject of agreements RT.2.01 through RT.2.09.” Because this item is merely a statement that no comment is needed, GEN.1.01 (42) should be closed and removed from consideration in the resolution of agreements RT.2.01 through RT.2.09.

Agreement RT.3.08 requests justification that microspheres can be used as analogs for colloids in tests. DOE recently submitted a separate letter<sup>4</sup> and associated report (Reimus, 2002b) designed to address RT.3.08. A subsequent NRC review and response<sup>5</sup> has been forwarded to DOE. Because the “Test Plan for: Laboratory Sorption Measurements – SZ” (Reimus, 2002a) does not provide specific additional information to address comments in the NRC’s response letter of August 2002, the status of agreement RT.3.08 should not be changed and should continue to be listed as “need additional information.”

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<sup>2</sup>Ziegler, J. “Transmittal of Report Addressing Key Technical Issue (KTI) Agreement Radionuclide Transport (RT) 2.05.” Letter (September 20, 2002) to J. Schlueter.

<sup>3</sup>Reamer, C.W. “U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Range of Thermal Operating Temperatures (September 18–19, 2001).” Letter (October 2, 2001) to S. Brocoum, DOE.

<sup>4</sup>Ziegler, J. “Transmittal of Report Addressing Key Technical Issues (KTI).” Letter (April 26, 2002) to J. Schlueter.

<sup>5</sup>Schlueter, J. “Radionuclide Transport Agreement 3.08.” Letter (August 16, 2002) to J. Ziegler.

The enclosed test plan (Reimus, 2002a) provides a general description of experimental activities designed to support the DOE's Total System Performance Assessment by obtaining estimates of sorption and transport parameters for the saturated alluvium and by reducing their uncertainties in saturated zone models. The specific objectives identified in the test plan are (1) determination of radionuclide sorption and desorption parameters for use in performance assessment and process-level models and (2) determination of whether natural colloids can significantly facilitate the transport of strongly-sorbing actinides in the saturated alluvium south of Yucca Mountain.

The scope of work outlined in the test plan (Reimus, 2002a) includes continuation of batch sorption and column transport with specific tasks focusing on studies with materials collected from drill holes other than NC-EWDP-19D/19P, studies of the effects of variable redox conditions, and work to investigate effects of mineralogy on sorption. The scope of work also includes several colloid-related tasks such as extended analyses of colloid concentrations and distributions in Nye County wells and analyses comparing the transport of carboxylate-modified latex microspheres and natural colloids in saturated alluvium.

The test plan (Reimus, 2002a) briefly provides a discussion of laboratory transport tests and a summary of results from laboratory tests conducted since August 1999. The test plan notes that quantitative pre-test predictions are not quite applicable for the proposed studies because the studies are primarily observational in nature, but the plan does provide a qualitative description of experiment expectations based on previous experience and results derived from the literature.

A general discussion of the methodology of batch sorption, desorption and column transport test is also provided. The discussion includes a list of possible analyses, analytical methods, and models used to garner and interpret results.

#### Staff Comments

The "Test Plan for: Laboratory Sorption Measurements – SZ" (Reimus, 2002a) provides a concise description of DOE laboratory-based activities intended to support characterization and understanding of transport processes in the saturated alluvium south of Yucca Mountain. Planned work to include materials beyond those obtained from drill hole NC-EWDP-19D/19P and to further investigate the potential effects of colloid-facilitated transport is encouraged by NRC staff. Although not explicitly identified as such in the test plan, the colloid experiments may also support additional information requests for RT.3.08.

The test plan (Reimus, 2002a) notes that the chemistry of solutions in sorption experiments may be varied to study reducing or low-oxygen conditions, dependent on measured Eh conditions in the field. The plan also identifies tasks to further study and incorporate variation in alluvium mineralogy in the sorption and transport testing. The test plan does not identify plans to examine other variations in solution chemistry, such as pH and dissolved carbonate concentration, that are known to have a significant effect on the values of sorption coefficients. These effects are evident in the discussion of low uranium distribution coefficients on page 8 of the report (Reimus, 2002a), which are likely due to the effects of carbonate complexation of uranyl species.

The test plan and cover letter make several references to activities added as a result of the deferral of the field-based transport testing at the Alluvial Testing Complex. It is difficult, however, to identify what tests or types of tests were added to compensate for the loss of field testing. It is noted that the studies outlined in the test plan, if completed as described, can provide important information to inform performance assessment and process-level models and timely information needed to understand transport processes in the saturated alluvium.

The test plan (Reimus, 2002a) as provided is consistent with the scope and intent of the agreement. As noted in the agreement, the following comments are provided for DOE's consideration.

1. Field and laboratory chemical analyses of waters from Nye County wells appear to show little variation in Eh (virtually all are oxidizing) but show substantive variation on pH and carbonate concentration. Given the sensitivity of actinide sorption to variations in these two parameters, NRC staff recommend that the scope of work for lab sorption tests be expanded to include investigation of the effects of variations in pH and dissolved carbonate.
2. Results of previous Np sorption/desorption experiments discussed in the test plan indicate incomplete desorption of Np that could be interpreted as irreversible sorption behavior. Recent modeling studies conducted by CNWRA reveal that the degree of irreversibility is an important parameter in the potential for colloid facilitated transport of Pu (Cvetkovic et al., 2002; Painter et al., 2002). If Np sorption on colloids is also irreversible to some degree, this could have implications on its transport via colloids. Thus, the importance of understanding colloid transport may extend beyond effects on highly sorbing nuclides such as Pu and Am.

Additional information needs: None

Status of Agreements: Agreement RT.2.05 is considered complete. GEN.1.01(42) should be considered complete.

## References

Bechtel SAIC Company, LLC. "FY01 Supplemental Science and Performance Analyses." Vol. 1: Scientific Bases and Analyses. TDR-MGR-MD-000007. Revision 00 ICN 01. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2001.

Cvetkovic, V. S Painter, D. Pickett and D Turner. "Transport of plutonium by inorganic colloids: From laboratory to field-scale applications." Presented at International Workshop on colloids and Colloid Facilitated Transport of Contaminants in Soils and Sediments, Tjele, Denmark. September 2002.

Painter, S., V. Cvetkovic, D. Pickett, and D. Turner. 2002. Significance of kinetics for sorption on inorganic colloids: Modeling and data interpretation issues. *Environmental Science and Technology* (in press).

Reimus, P. "Test Plan For: Laboratory Sorption Measurements – SZ." SITP-02-SZ-004 (Revision 01). Las Vegas, Nevada: Bechtel SAIC Company. August, 2002.

Reimus, P. "The Use of Polystyrene Microspheres As Tracer Surrogates for Inorganic Groundwater Colloids." Rev 00 (document number unknown) Las Vegas, Nevada: Bechtel SAIC Company. April, 2002.