# U.S. NUCLEAR REGULATORY COMMISSION, OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS, REVIEW OF THE U.S. DEPARTMENT OF ENERGY'S AGREEMENT RESPONSES RELATED TO THE POTENTIAL GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA: ADDITIONAL INFORMATION NEED FOR KEY TECHNICAL ISSUE AGREEMENTS TO RADIONUCLIDE TRANSPORT 3.05, COMMENT 8, AND STRUCTURAL DEFORMATION AND SEISMICITY 3.01

## 1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) issue-resolution goal during the prelicensing period is to identify and resolve, if possible, technical issues prior to receipt of a License Application. NRC staff resolution of an issue during prelicensing does not preclude the raising of related issues during the licensing proceedings. Also, and equally important, NRC resolution of an issue during prelicensing does not prejudge NRC staff's evaluation of the issue during the licensing review. NRC staff considers an issue resolved during prelicensing when it has no further questions nor comments about how U.S. Department of Energy (DOE) is addressing an issue. Pertinent new information could raise new questions or comments about a previously resolved issue.

This review addresses information DOE supplied in its December 22, 2006, letter (Williams, 2006) to the Director, Division of High-Level Waste Repository Safety, NRC. The letter responded to a staff Additional Information Need (AIN) for Key Technical Issue (KTI) Agreements Radionuclide Transport (RT) 3.05 and Structural Deformation and Seismicity (SDS) 3.01, and for Comment 8, pertaining to KTI Agreements RT 3.06 and SDS 3.02. All the subject agreement items relate to the Alcove 8–Niche 3 unsaturated zone field tests conducted by DOE at Yucca Mountain. These tests investigated flow and transport between the floor of Alcove 8, located in the Enhanced Characterization of the Repository Block Cross Drift (ECRB), and the ceiling of Niche 3, located about 20 meter (m) [65.6 feet (ft)] below in the Main Drift of the Exploratory Studies Facility (ESF). Between March 2001 and October 2004, two major flow and transport tests were conducted at this site: the fault infiltration test and the large-plot infiltration test.

Agreements SDS 3.01 and SDS 3.02 were originally made between DOE and NRC during the Technical Exchange and Management Meeting on Structural Deformation and Seismicity held October 11 to 12, 2000, in Las Vegas, Nevada (Reamer and Gil, 2000). Agreements RT 3.05 and RT 3.06 were originally made during a Technical Exchange and Management Meeting on RT held December 5 to 7, 2000, in Berkeley, California (Reamer and Williams, 2000).

Agreement SDS 3.01 involves a request to "fracture-inform" the Alcove 8–Niche 3 testing by relating observed seepage data to observed fracture patterns. In response to SDS 3.01, DOE provided a letter on September 18, 2001, regarding a 3-dimensional depiction of fractures between Alcove 8 and Niche 3 (Brocoum, 2001). On November 19, 2001, DOE subsequently provided a document about the process and methodology used to develop the 3-dimensional depiction of fractures (Williams, 2001). After reviewing the transmitted information, NRC issued SDS 3.01 AIN-1, requesting DOE to show that the hydrologic and transport tests had been, or would be, interpreted with consideration of fracture-fault patterns and lithostratigraphic field data in the test vicinity (Schlueter, 2002).

Agreements RT 3.06 and SDS 3.02, which have identical wording, request that DOE document the pre-test modeling predictions for the Alcove 8–Niche 3 field tests. In response to Agreements RT 3.06 and SDS 3.02, DOE provided a letter on June 27, 2002, transmitting a report that was an updated pre-test prediction of tracer transport for the Alcove 8–Niche 3 fault test (Ziegler, 2002). The NRC staff review of this response generated a set of eight specific comments, which were included in a February 14, 2003, letter to DOE (Schlueter, 2003).

Agreement RT 3.05 requests documentation of the Alcove 8–Niche 3 unsaturated zone field tests and predictive modeling for the unsaturated zone.

By letter dated July 28, 2004, DOE transmitted a report, Appendix H of Technical Basis Document No. 3: "Water Seeping into Drifts" (Bechtel SAIC Company LLC, 2003a), that contained the DOE responses to Agreement Item RT 3.05 and to SDS 3.01 AIN-1 (Ziegler, 2004). The report also included DOE responses to the eight specific comments that arose from the NRC review of the DOE response to Agreements RT 3.06 and SDS 3.02. In a letter to DOE dated April 8, 2005, NRC provided an evaluation of the DOE response, which resulted in RT 3.05 AIN-1 and SDS 3.01 AIN-2 (Kokajko 2005). In the same letter, NRC indicated that only Comment 8 of the eight specific comments required additional information, and that the information needed to address RT 3.05 AIN-1 would also serve to address Comment 8 AIN-1.

In a letter dated December 22, 2006, DOE transmitted additional information to NRC for RT 3.05 AIN-1 and SDS 3.01 AIN-2, and for Comment 8 AIN-1 of the NRC evaluation of DOE responses to KTI Agreements RT 3.06 and SDS 3.02 (Williams, 2006). The letter presented summary responses to the items and provided more detailed information in three contractor reports: "Analysis of Alcove 8/Niche 3 Flow and Transport Tests" (Bechtel SAIC Company, LLC, 2006), "In Situ Field Testing of Processes" (Bechtel SAIC Company, LLC, 2004a), and "UZ Flow Models and Submodels" (Bechtel SAIC Company, LLC, 2004b). As noted in a follow-up letter from DOE on March 09, 2007 (Williams, 2007), the transmittal letter (Williams, 2006) cited the report, "Analysis of Alcove 8/Niche 3 Flow and Transport Tests" (Bechtel SAIC Company, LLC, 2006) as Revision 01, but the correct identification should be Revision 00.

This report contains a staff review of DOE's responses to RT 3.05 AIN-1, Comment 8 AIN-1, and SDS 3.01 AIN-2, based on the information provided by Williams (2006).

## 2.0 WORDING OF AGREEMENTS SDS 3.01 AIN–2, RT 3.05 AIN-1, AND COMMENT 8 AIN-1

### Agreement SDS 3.01 AIN–2

The wording of SDS 3.01 AIN-2 is summarized as follows:

> Although DOE staff made some efforts toward fracture-informing the infiltration and seepage results of the Alcove 8–Niche 3 large-plot test, they did not conduct these analyses for the fault test. DOE should explain what was learned about the hydrologic characteristics of the fault under the conditions of the fault test, or the effects of the fault on the infiltration and seepage results, or demonstrate that the fault had little or no impact on the test results. As such, NRC considers DOE's response to SDS 3.01 AIN–1 to be insufficient for completion of the agreement at this time.

Agreement RT 3.05 AIN-1

The wording of RT 3.05 AIN-1 is summarized as follows:

> Appendix H of Bechtel SAIC Company, LLC (2003a) does not provide a discussion of results for the tracer testing conducted at Alcove 8–Niche 3, nor does it provide information or interpretation of results compared to pretest predictive modeling. . . . Until DOE publishes the results of the remaining tracer tests and comparison of results to the pretest predictions, the staff considers Agreement RT 3.05 as incomplete.

Comment 8 AIN--1

The wording of Comment 8 AIN-1 is as follows:

> Comment 8 requests descriptions of all features, events, and processes observed in the Alcove 8–Niche 3 tests. The DOE response and the Analysis Model Report for *in-situ* testing (Bechtel SAIC Company, LLC, 2003b) provide detailed descriptions of experimental initial and boundary conditions, observed fracture patterns, a discussion of the relation of seepage and infiltration rates with observed fracture patterns, and the results and interpretations of tracer transport tests. As discussed in the staff evaluation of Agreement RT 3.05 herein, DOE's response does not provide a discussion of results for the tracer testing conducted at Alcove 8–Niche 3, nor does it provide information or interpretation of results compared to pretest predictive modeling. The additional descriptions of test results needed to address Agreement RT 3.05 would serve to address this comment.

## 3.0 SIGNIFICANCE TO PERFORMANCE

Agreement SDS 3.01 AIN–2 requests DOE to explain how or if characteristics of the fault and fractures affected the infiltration and seepage results of the fault test (Kokajko, 2005). Interpretation of test results in terms of the fracture-fault patterns (as documented in the full-periphery geologic mapping) and other fracture data and lithostratigraphic information is important because it can help us understand the infiltration and seepage observations and correlate them to the numerical model results. This, in turn, provides technical basis for the seepage abstraction in performance assessment. Quantitative descriptions of fracture characteristics at the test locations and interpretation of test results in terms of these characteristics support the technical bases of the DOE fracture-continuum approach to drift-scale seepage modeling. The "Unsaturated Zone (UZ) Flow Models and Submodel Analysis Model Report" (Bechtel SAIC Company, LLC, 2004b) states that "...data from Alcove 8/Niche 3 flow and seepage test results are used to validate the UZ flow model. The tests involve a fault test and a large-infiltration-plot test." NRC has assigned a high risk significance to the process of seepage into drifts (NRC, 2005) because it could significantly affect repository releases.

Agreement RT 3.05 AIN-1 requests a discussion of the results for the large-plot tracer tests in Alcove 8–Niche 3, and an interpretation of the test results as compared to pretest predictive modeling (Kokajko, 2005). DOE has identified radionuclide transport in the unsaturated zone as a principal factor of the postclosure safety case, with diffusion into the matrix and sorption on matrix minerals described as potentially significant contributors to waste isolation (Bechtel SAIC Company, LLC, 2004c). Given the importance attributed by DOE to matrix diffusion as a potential retardation mechanism, and the uncertainties and relative scarcity of field data about fracture-matrix interactions in unsaturated flow regimes, NRC has assigned a medium risk significance to matrix diffusion, with respect to radionuclide transport in the unsaturated zone (NRC, 2005).

## 4.0 EVALUATION AND COMMENT

### 4.1 Background

The Alcove 8–Niche 3 field tests are described in Bechtel SAIC Company, LLC (2004a) and Bechtel SAIC Company, LLC (2006). Alcove 8, excavated from the ECRB, is located in the Topopah Spring Tuff, upper lithophysal zone subunit of the Topopah Spring welded unit. Niche 3, a small extension off the ESF main drift, is located approximately 20 m [65.6 ft] directly below Alcove 8 in the Topopah Spring Tuff, middle nonlithophysal zone subunit, which is a densely welded, highly fractured devitrified tuff containing no lithophysal cavities. The gradational contact between the two subunits is approximately 15 m [49.2 ft] below the floor of Alcove 8. A distinctive feature of Alcove 8 is a minor near-vertical fault that intersects the alcove. The fault is open on the alcove ceiling, appears to be closed on the floor, and is visible as a fracture in the ceiling of Niche 3. The fault is exposed in the ESF at the Niche 3 entrance.

Two major long-term field experiments, informally called the fault test and the large-plot test, were conducted in the Alcove 8–Niche 3 program. In the fault test (March 2001 to August 2002), tracer-free and tracer-laced water were introduced into a shallow, narrow trench along the fault in the floor of Alcove 8. The progress of the water through the rock was monitored by boreholes fitted with electrical resistivity probes and by seepage in and near the fault trace in the ceiling of Niche 3. In the large-plot test (August 2002 to October 2004), ponded water was released into 12 subplots that formed a 3 m by 4 m [9.8 ft by 13.1 ft] grid on the floor of Alcove 8. A tracer test was conducted in the third stage of the large-plot test, during which seepage rates unexpectedly declined to near zero and no tracers were detected in the Niche 3 seepage for more than 5 months, at which time the experiment was briefly interrupted to scrub biofilms from the floors of several of the infiltration subplots in Alcove 8. This activity was followed by a sharp pulse in infiltration and seepage rates, after which low but detectable concentrations of a few of the tracers were observed in the Niche 3 seepage in the final weeks of the test.

In terms of field data, the DOE representation of unsaturated zone fractures typically has been limited to mapped fractures with trace lengths greater than 1 m [3.28 ft] (Mongano, et al., 1999). Fractures at this scale are likely to play a major role in conducting flow under fully saturated conditions. However, under unsaturated conditions, smaller and less obvious interconnected fractures with the narrowest apertures may control flow patterns, capillary diversion, and seepage, because these are the fractures with the highest capillary strength. In SDS 3.01 (Reamer and Gil, 2000) and in the subsequent SDS 3.01 AIN-1 (Schlueter 2002), both of which were initiated during the early or planning stages of the Alcove 8–Niche 3 field tests, NRC requested that DOE fracture-inform the tests by relating the actual or expected test results to the full set of available fracture-fault data and lithostratigraphic information for the Alcove 8–Niche 3 test volume. In evaluating the DOE response to SDS 3.01 AIN-1, NRC acknowledged (Kokajko, 2005) that DOE staff had made some efforts toward fracture-informing the infiltration and seepage results of the Alcove 8–Niche 3 large-plot test, but DOE had not provided similar fracture-informed analyses for the fault test. In SDS 3.01 AIN-2, DOE was asked specifically to indicate what had been learned about the properties of the fault from the infiltration and seepage data, or what was learned about the effects of the fault on the infiltration and seepage tests (Kokajko, 2005).

In Kokajko (2005), NRC noted that the Alcove 8–Niche 3 tests provided an opportunity to test the conceptual model of matrix diffusion in the unsaturated zone at an intermediate scale relevant to the potential repository. Moreover, the tests were of practical interest because they were conducted in densely welded rocks of the Topopah Spring Tuff that are specifically part of the lithostratigraphic subunits for a potential repository. The scale and setting of the tracer tests provided a potential means to build confidence in modeling of radionuclide transport in the unsaturated zone. As an indication that matrix diffusion was an important process affecting transport, DOE had presented tracer test results from the Alcove 8–Niche 3 fault test that were consistent with expected behavior (Bechtel SAIC Company, LLC, 2003b, and Liu, et al., 2004). The large-plot infiltration test provided an opportunity to obtain additional insights into the processes affecting radionuclide transport in the unsaturated zone and the capabilities of DOE transport models to adequately capture these processes. During the large-plot test and after its conclusion, several agreement items and AINs requested that DOE provide the large-plot test results, including the tracer results and the related modeling. All three stages of the large-plot tracer test and related modeling were documented in the report provided by DOE in response to RT 3.05 AIN-1 and Comment 8 AIN-1 (Bechtel SAIC Company, LLC, 2006).

4.2 Agreement SDS 3.01 AIN-2

In response to SDS 3.01 AIN-2, which requested that DOE provide a fracture-informed analysis of the Alcove 8–Niche 3 fault tests, DOE provided a description of the fault test set-up and observations in “In Situ Field Testing of Processes” (Bechtel SAIC Company, LLC 2004a, Section 6.12), and a modeling study of the fault test in “UZ Flow Models and Submodels” (Bechtel SAIC Company, LLC 2004b, Section 7.6). In the model analysis, the seepage and water-travel-velocity data first were used to obtain calibrated rock properties and the corresponding flow field. The calibrated model then was used for tracer transport simulations to represent the effects of matrix diffusion and other processes on solute transport in the fault. The calibration of rock properties based on seepage and water-travel-velocity data indicated that fault permeability was 2 to 3 orders of magnitude greater than that of the adjacent fractured rock. DOE provided no evaluation of the overall effects of the fault on infiltration and seepage in the test volume, (e.g., by comparing the model with simulations in which the fault was removed from the system). The fault was represented in the model as a simple planar feature, but the modelers found it necessary to increase the effective fracture-matrix interface area to a value greater than the geometric surface area, to simulate the observed tracer results. The modelers noted that this increase, which assumed that the faulted rock was structurally more complex than represented in the model, was comparable to the calibration needed to enhance the magnitude of the matrix diffusion coefficient in modeling tracer results from other unsaturated zone transport tests (e.g., Wu, et al., 2001, and Liu, et al., 2003).

The analysis of the fault test in the documents presented by DOE in Williams (2006) involved little or no direct consideration of the available fracture data or lithostratigraphic data for the Alcove 8–Niche 3 field tests. Moreover, the conceptualization of the model in the documents does not incorporate features of a 3-dimensional depiction of fractures between Alcove 8 and Niche 3, that DOE originally provided in response to SDS 3.01, to indicate that the Alcove 8–Niche 3 tests would be fracture-informed (Brocoum 2001). As interpreted and modeled, seepage in the fault test appears to have been controlled mainly by: (i) the fault and intersecting fractures; (ii) imbibition of water at fault-matrix and fracture-matrix interfaces; and (iii) diversion of water at the Niche 3 ceiling because of the capillary barrier effect. The model did not directly consider structural or lithostratigraphic features such as subhorizontal fractures throughout the tuff, or small fractures connected to lithophysae. The subhorizontal fractures are potentially important flow pathways at low infiltration and may have diverted a substantial amount of water from the fault and bypassed Niche 3. Fracture-connected lithophysae may have contributed to trapping and holding a measurable amount of water over the timeframe of the test. From a practical perspective, for the large-plot test, Bechtel SAIC Company, LLC (2006) noted that rock dust and cuttings from excavation procedures may have obstructed some fractures in the floor of Alcove 8, with varying effects on infiltration as the particles were transported downwards and clogged some pathways or diverted water elsewhere. The fault test was similarly affected by dust and particle clogging from excavation of the infiltration trench. This effect has contributed to uncertainty in modeling the observed infiltration and seepage rates. DOE accounted for the unrepresented features and processes by increasing the modeled effective fracture-matrix interface area. In the model, this increased the effectiveness of matrix diffusion and generally reproduced the observed fault test tracer transport rates, but it is not established that this approach could be applied successfully to predictive modeling at another location.

Compared with the approach implemented in Bechtel SAIC Company, LLC (2003a) to fracture-inform the large-plot test, the information provided by Williams (2006) indicates that no significant attempt has been made to fracture-inform the fault test or to interpret test results with respect to the contribution of the fault to the observed test results. NRC staff considers that the information presented so far by DOE is insufficient to meet SDS 3.01 AIN-2.

4.3 Agreement RT 3.05 AIN-1 and Comment 8 AIN-1

In response to AIN RT 3.05 AIN-1, about the results and predictive modeling of the large-plot infiltration test, DOE provided the report, "Analysis of Alcove 8/Niche 3 Flow and Transport Tests" (Bechtel SAIC Company, LLC, 2006), which presents a description of the test methods and observations, pre-test predictions and comparison with observed results, model results based on calibration with all available infiltration and seepage data, and a discussion of the interpreted results and uncertainties. Staff considers that DOE has sufficiently addressed the request to document the remainder of the results of the Alcove 8–Niche 3 field tests, and RT.3.01 AIN-1 and Comment 8 AIN-1 are now considered complete. With regard to the information presented in Bechtel SAIC Company, LLC (2006) about the large-plot test, NRC staff have the following observations, which DOE may wish to consider in developing its license application.

Given that the Alcove 8–Niche 3 large-plot infiltration test was the largest and most complex unsaturated zone tracer test at Yucca Mountain, DOE's documented analyses of the results of these experiments and comparison with pre-test predictions in Bechtel SAIC Company, LLC (2006) are of considerable interest in evaluating DOE's understanding of flow and transport processes potentially important to the performance of a potential repository system, particularly with respect to model uncertainty and data uncertainty. A lack of correspondence between experiment results and pre-test predictions in the large-plot test, largely because of the unanticipated variation in infiltration and seepage rates and uncertainties about the transport path of tracers before the infiltration pulse near the end of the test, was well-acknowledged in

Bechtel SAIC Company, LLC (2006). Multiple recalibrations of the model were required to simulate observed infiltration rates, seepage, and tracer transport. DOE proposed that one cause of the observed variability may have been the transient clogging of fractures with dust and other particles that were gradually transported downwards from the floor of Alcove 8.

Another unexpected result of the large-plot test was that, contrary to pre-test predictions, no tracers were detected in Niche 3 for more than 5 months after the tracer test began in Alcove 8. During this time, seepage in Niche 3 decreased to essentially zero, but the decline was not associated with a significant drop in infiltration rate in Alcove 8. Scrubbing the infiltration pans to remove accumulated biofilms produced abrupt infiltration pulses in two of the subplots, followed by increased seepage in Niche 3, with low, but detectable concentrations of the specific tracers that were associated with those two subplots. The large-plot test was terminated before tracers from any other Alcove 8 subplots were definitively observed in the seepage water. BSC (2006) proposed several explanations for these observations (e.g., transport paths blocked by debris particle accumulation, effectiveness of matrix diffusion, adsorption or obstruction of tracers by biofilms) but presented little or no data to support the explanations.

In summary, the Alcove 8–Niche 3 field tests provided an opportunity to evaluate the abstraction of unsaturated zone process models for performance assessment on an intermediate scale and in particular to test the conceptual model of matrix diffusion in a geologically realistic setting for a potential repository. Although DOE has indicated that the Alcove 8–Niche 3 tests do not directly support the development nor abstraction of unsaturated zone process models for performance assessment (Bechtel SAIC Company, LLC, 2003c, Appendix E), the objectives of the tests were to provide information to support the representation of: (i) the movement of water through faults and fractures; and (ii) fracture-matrix interaction mechanisms (e.g., matrix diffusion) in the unsaturated zone, in process-level and performance assessment models. The questions raised by the unexpected results of the tests suggest that the magnitude of model uncertainty associated with unsaturated zone transport appears larger than anticipated, and the conceptual models may not account for all processes observed in the Alcove 8–Niche 3 tests. Additionally, the test results do not appear directly applicable to other upper lithophysal-middle nonlithophysal gradational contact zones with or without faults, based on current information.

## 5.0 SUMMARY

The NRC staff evaluated the DOE response to RT 3.05 AIN-1 requesting a discussion of the results of the large infiltration plot tracer tests with a comparison to pretest predictive modeling of those tests. Comment 8 AIN-1 requests descriptions of all features, events, and processes observed in the Alcove 8-Niche 3 large infiltration plot tracer tests. NRC acknowledged that additional descriptions of tracer test results needed to address Agreement RT 3.05 would serve to address Comment 8 AIN-1. DOE has been responsive by providing results of the tracer tests and comparing them to pretest predictions. Consequently, the NRC staff concludes that RT 3.05 AIN-1 is closed. The staff acknowledges that these experiments are complex and difficult to control. Nevertheless, the staff has the following technical concerns:

1. The necessity to recalibrate system parameters after each stage of the experiments to fit field observations of infiltration, seepage, and tracer breakthroughs and concentrations suggests limited capability to model flow and transport in the fractured

unsaturated zone.

2. Scrubbing of infiltration pans produced unpredicted effects on these same observations. With the termination of experiments in Alcove 8-Niche 3, speculation remains on alternative mechanisms controlling flow and transport in the unsaturated fractured medium.

With regard to Comment 8 AIN-1, DOE's description of the biofilm occurrence as a feature, event, or process at Alcove 8-Niche 3 is an adequate response. The NRC staff considers this AIN closed. However, the staff has the following technical concern:

3. The existence of biofilms on fracture surfaces is an additional uncertainty affecting flow and transport in the fractured unsaturated zone.

With regard to SDS 3.01 AIN-2, instead of providing a fracture-informed analysis of the Alcove 8–Niche 3 fault tests, DOE provided a description of the fault test set-up, the experimental observations, and a modeling study of the fault test. The model analysis used seepage and water-travel-velocity data to obtain calibrated rock properties and the corresponding flow field, which was then used for tracer transport simulations. Fault permeability was 2 to 3 orders of magnitude greater than that of the adjacent fractured rock. Water-travel-velocity data provided information on the porosity of the fault-fracture network. DOE provided no evaluation of the overall effects of the fault on infiltration and seepage in the test volume (e.g., by comparing the model with simulations in which the fault was removed from the system). As a result, the staff has the following remaining technical concerns:

1. The analysis of the fault test in the documents referred to in Williams (2006) involved little or no direct consideration of the available fracture data or lithostratigraphic data for the Alcove 8–Niche 3 field tests, nor did the conceptualization of the model in the documents incorporate features similar to the 3-dimensional depiction of fractures between Alcove 8 and Niche 3 that DOE originally provided in response to SDS 3.01 to indicate that the Alcove 8–Niche 3 tests would be fracture-informed (Brocoum 2001).

2. The interpretation of the fault test results did not sufficiently consider structural features such as the intersection of the subvertical fault with subhorizontal fractures throughout the tuff, and the potential role that these subhorizontal fractures had in diverting water from the fault and bypassing Niche 3.

3. Further, the interpretation of the fault test results did not directly evaluate connection of the fault to subhorizontal fractures, connection of subhorizontal fractures to vertical fractures, connection of lithophysae to both sets of fractures and, consequently, the potential role that these fracture-connected lithophysae had in trapping infiltrated water.

4. Instead of considering unrepresented features and processes such as those mentioned above, DOE increased the modeled effective fracture-matrix interface area in the model to account for those unrepresented features and processes. This approach increased the effectiveness of matrix diffusion, which allowed the model to reproduce the observed fault test results. Application of this approach in predictive modeling at other locations is uncertain.

Compared with the approach implemented in Bechtel SAIC Company, LLC (2003a) to fracture-inform the large-plot test, the information provided by Williams (2006) does not indicate a significant attempt to fracture-inform the fault test, nor to interpret test results with respect to the contribution of the fault to the observed test results. NRC staff considers that the information presented by DOE is insufficient to meet SDS 3.01 AIN-2.

The NRC staff has adopted a risk-informed performance-based approach to evaluating regulatory compliance. As one example of a path forward, the staff considers that analyses of the uncertainties associated with the testing in Alcove 8-Niche 3, such as those discussed in this section of the review could be performed by DOE, to estimate the significance on total system performance.

## 6.0 STATUS OF THE AGREEMENTS

Based on the information provided by DOE (Williams, 2006) and the preceding review, NRC staff has no further questions at this time, with respect to RT 3.05 AIN-1 and Comment 8 AIN-1, and NRC considers those agreements closed. NRC staff considers that DOE has provided insufficient information to satisfy SDS 3.01 AIN-2. That item remains open. It is for DOE to decide how, or whether, to respond further to this request for information. Note that NRC will make its final determination regarding any issues relevant to licensing during review of a potential license application.

## 7.0 REFERENCES

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