# THE U.S. NUCLEAR REGULATORY COMMISSION OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS REVIEW OF THE U.S. DEPARTMENT OF ENERGY'S KEY TECHNICAL ISSUE AGREEMENT RESPONSES RELATED TO THE POTENTIAL GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA: GENERAL 1.01, COMMENTS 81 AND 104

## 1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) issue resolution goal during this interim pre-licensing period is to ensure U.S. Department of Energy (DOE) has assembled sufficient information about a given issue for NRC to accept a potential License Application for review. Resolution by NRC staff during pre-licensing does not prevent anyone from raising any issue for the NRC staff consideration during the licensing proceedings. It is equally important to note that resolution of an issue by NRC staff during the pre-licensing period does not prejudge the NRC staff evaluation of the issue during the licensing review. Issues are resolved by the NRC staff during pre-licensing when the staff have 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. The NRC licensing decision will be based on information provided as part of a potential License Application.

By letter dated November 25, 2003, DOE submitted a report titled "Technical Basis Document No. 5: In-Drift Chemical Environment" (Bechtel SAIC Company, LLC, 2003a) to satisfy the informational needs of numerous key technical issue (KTI) agreements pertaining to the in-drift chemical environment and to respond to issues raised by the NRC staff about the chemical environment on the surfaces of the waste package and drip shield at the potential repository at Yucca Mountain, Nevada. Appendix B of Bechtel SAIC Company, LLC (2003a) contains DOE's response for Agreement General (GEN) 1.01, Comments 81 and 104. The DOE stated in the technical basis document that the NRC information needs regarding the GEN.1.01, Comments 81 and 104 have been satisfied, and should be considered closed.

Section 2.0 of this report provides NRC staff evaluation of the extent to which DOE submittal satisfies the informational requirements of GEN.1.01, Comments 81 and 104. Other agreements covered in Bechtel SAIC Company, LLC (2003a) are addressed in separate letters. Section 3.0 provides a summary and status of the agreement.

## 2.0 REVIEW OF INFORMATION PROVIDED FOR GEN.1.01, COMMENTS 81 AND 104

### 2.1 Wording of Agreement

Agreement GEN.1.01 was reached at a meeting held September 18–19, 2001, to discuss the range of thermal operating temperatures (Reamer, 2001). The wording of Comments 81 and 104 is as follows.

GEN.1.01, Comment 81 [Note: The page and section numbers cited in the agreement refer to Bechtel SAIC Company, LLC (2001)].

"More Comments on the abstraction of uncertainty:"

"Page 3-57: It is unclear how the mountain-scale THC model can address uncertainties in the drift-scale THC seepage models. If the mountain-scale models predict bulk changes to some things, like large-scale gas convection or lateral flow, this would change the boundary conditions to the THC seepage models. If the THC seepage models are not run with the altered boundary conditions, it is unclear how they would evaluate the impact."

"Page 3-66. The ranges in water and gas compositions are wider than those predicted by the drift-scale THC models at a given time as a direct result of edge effects."

"Page 3-70: The argument that thermal-hydrological-mechanical processes result in a change to permeability fields that are within the original uncertainty distribution, and are therefore unimportant needs quantification. The process would likely result in a shifting of the mean or median of the distribution and changes to its shape. Having a broad uncertainty distribution may not encompass this effect."

GEN.1.01, Comment 104 [NOTE: The page and section numbers cited in the agreement refer to Bechtel SAIC Company, LLC (2001)].

"The DOE has not adequately addressed the possibility that edge effects predicted by the 3–D mountain scale thermal-hydrologic model (Section 3.3.6) could influence results from the coupled THC models (Section 4.3.6)."

## 2.2 Relevance to Repository Performance

Total system performance assessment calculations of degradation of engineered barriers and radionuclide release from waste forms and waste packages depend on the abstraction of in-drift environment and the chemistry of water contacting the engineered materials. The total system performance assessment calculations need to adequately account for the uncertainty and variability in in-drift environment and water chemistry. Finally, the specific comments of GEN.1.01 are related to other KTI agreements, whose risk significance varies from low-risk to high-risk significance. Although GEN.1.01 was assigned as high-risk significance (Travers, 2003), the individual comments within GEN.1.01 were not separately categorized within the significance framework. Nevertheless, this review addresses those GEN.1.01 comments associated with ENFE.1.05, a medium-risk significance agreement (Travers 2003).

## 2.3 NRC Evaluation and Comments

Appendix B of the technical basis document (Bechtel SAIC Company, LLC, 2003a) provides a summary of information contained in Bechtel SAIC Company, LLC (2003b). The DOE states that variability in the natural system was addressed by evaluating results of thermal-hydrological-chemical simulations at mean and bounding conditions. The DOE identified bounding conditions to use in sensitivity analyses for the range of possible near-field geochemical environments. The range of conditions considered in the thermal-hydrological-

chemical simulations incorporated: (i) uncertainty and variability in initial water chemistry; (ii) carbon dioxide and soil boundary conditions determined from ambient geochemical measurements; (iii) spatial variability of model output; and (iv) uncertainty and variability of the model with respect to percolation flux. The DOE maintains that the ranges considered in the sensitivity analyses cover the potential variability of conditions across the repository, including the effects of repository-edge cooling and thermal-hydrological-mechanical processes specifically mentioned in Agreement GEN.1.01, Comments 81 and 104.

The NRC staff believes the range of conditions considered in the bounding thermal-hydrological-chemical simulations generally encompass the natural variability of the system. Mountain-scale convection may lead to different partial pressures of carbon dioxide, which were varied in DOE's thermal-hydrological-chemical simulations. Spatial variations are reflected in the modeling of different repository horizons. The effects of stress and strain on hydrological properties were used to assess the thermal-hydrological-mechanical effects on saturation and chemistry in the host rock surrounding the drifts. The NRC staff believes the information provided by DOE was responsive to the concerns of Agreement GEN.1.01, Comments 81 and 104. Therefore, NRC staff considers Agreement GEN.1.01, Comments 81 and 104 closed.

However, DOE should consider the following to improve the quality of any potential License Application: the effect on chemistry and seepage when the reflux zone stabilizes at or immediately above the drift crown at some location away from the central part of a potential repository (as caused by repository edge-cooling effects).

## 3.0 SUMMARY AND STATUS OF AGREEMENT

The NRC staff has reviewed DOE's KTI agreement responses within Appendix B of "Technical Basis Document No. 5: In-Drift Chemical Environment" (Bechtel SAIC Company, LLC, 2003a) to determine whether sufficient information was provided to complete the agreement. On the basis of this review, and notwithstanding new information that could raise new questions or comments concerning the above agreement, NRC staff believes the information provided by DOE satisfies the intent of Agreement GEN.1.01, Comments 81 and 104. Therefore, NRC staff considers Agreement GEN.1.01, Comments 81 and 104 closed.

## 4.0 REFERENCES

Bechtel SAIC Company, LLC. "Technical Basis Document No. 5: In-Drift Chemical Environment." Rev. 1. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2003a.

———. "Drift-Scale Coupled Processes (DST and THC Seepage) Models." MDL–NBS–HS– 000001. Rev. 02. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2003b.

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

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) to S. Brocoum, DOE. ML012820049. Washington, DC: NRC. 2001. <www.nrc.gov/waste/hlw-disposal/public-involvement/mtg-archive.html#KTI>

Travers, W. D. “Final Staff Response to March 19, 2003, Requirements Memorandum to the Waste Arena Briefing-M030303A:.” Leger (June 5) t o Chairman Diaz and Commissioners Discus, McGaffigan, and Merrfield. Washington, DC: NRC 2003 <www.nrc.gov/reading-rm/adams.