U.S. NUCLEAR REGULATORY COMISSION, OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS, REVIEW OF THE U.S. DEPARTMENT OF ENERGY AGREEMENT RESPONSES RELATED TO THE POTENTIAL GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA: KEY TECHNICAL ISSUE AGREEMENTS TO IGNEOUS ACTIVITY 2.11 ADDITIONAL INFORMATION NEED

1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) issue-resolution goal during the prelicensing period is to ensure that the U.S. Department of Energy (DOE) has assembled enough information about a given issue for NRC to accept a license application for review. 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 about how DOE is addressing an issue. Pertinent new information could raise new questions about a previously resolved issue.

2.0 WORDING OF THE AGREEMENT

Igneous Activity (IA) Key Technical Issues (KTI) Agreement 2.11 is defined in an NRC staff letter (Reamer, 2001), which summarized the IA Technical Exchange and Management Meeting held June 21–22, 2001. The wording of the agreements is as follows:

> Provide an analysis that shows the relationship between any static measurements used in the TSPA and expected types and durations of surface disturbing activities associated with the habits and lifestyles of the critical group. DOE will provide an analysis that shows the relationship between any static measurements used in the TSPA and expected types and durations of surface disturbing activities associated with the habits and lifestyles of the critical group in a subsequent revision to the AMR Input Parameter Values for External and Inhalation Radiation Exposure Analysis (ANL-MGR-MD-000001) or equivalent document. This will be available to the NRC in FY02.

The request for additional information reads (Reamer, 2004):

> Subsequent to the development of IA KTI Agreement 2.11, DOE developed the Environmental Radiation Model for Yucca Mountain that uses specific airborne mass loads for different indoor and outdoor activity levels on nominal soil deposits and potential volcanic deposits. Although staff agrees with the overall approach in the DOE Environmental Radiation Model for Yucca Mountain, staff concludes insufficient information is presented by DOE to support airborne mass load parameter ranges used in the Environmental Radiation Model for Yucca Mountain. Relative to the location of the reasonably maximally exposed individual, analog sites used by DOE to derive these parameter ranges have obvious differences in annual rainfall, soil moisture, particle size distributions, particle compositions, vegetative cover, and local meteorological conditions. The individual and cumulative effects of these differences have not yet been adequately evaluated by DOE. Nevertheless, available information allows staff to

conclude that these differences could affect airborne mass load parameter ranges in Bechtel SAIC Company, LLC (2003a,b), and that these parameter ranges may be underestimated for the location of the reasonably maximally exposed individual. In addition, available data indicates that walking on deposits likely produces elevated airborne mass loads, which are not accounted for in current exposure times for outdoor active conditions (Bechtel SAIC Company, LLC, 2003d). Many of the current parameter ranges also use 24-hour averages of mass load measurements which likely underestimate airborne mass load ranges appropriate for shorter exposure periods during a day.

3.0 TECHNICAL INFORMATION PROVIDED BY DOE

This review addresses additional information DOE supplied in its September 26, 2006, letter, from Mark H. Williams, to the Director, Division of High-Level Waste Repository Safety. DOE initially responded to IA 2.11 in Appendix A to the report *Technical Basis Document #12: Biosphere Transport* (BSC, 2003). A subsequent NRC request for additional information (Reamer, 2004) led to the September 26, 2006, DOE letter. This letter included a copy of the model report *Inhalation Exposure Input Parameters for the Biosphere Model* (ANL-MGR-MD-000001, Revision 04) (BSC, 2006). The letter describes how the enclosed report contains information on the expected airborne mass loadings in the nominal and post-volcanic scenarios.

The *Biosphere Model Report* (BSC, 2004) describes the biosphere model that supports the DOE Total-System Performance Assessment. This model uses a microenvironmental approach for calculating a dose to a reasonably maximally exposed individual. Although NRC does not require such an approach, it is considered a reasonable approach for estimating an appropriate average annual intake. Different mass loads for these microenvironments are developed for nominal and volcanic scenarios, primarily supported by data and methods in the report *Inhalation Exposure Input Parameters for the Biosphere Model* (ANL-MGR-MD-000001, Revision 04) (BSC, 2006). The representative activities, average daily duration, and breathing rate for each microenvironment are described in *Characteristics of the Receptor for the Biosphere Model* (ANL-MGR-MD-000005, Revision 03) (BSC 2004).

4.0 SIGNIFICANCE TO PERFORMANCE

IA KTI Agreement 2.11 is relevant for understanding important aspects of IA Subissue 2, “Consequences of Igneous Activity,” and has been reviewed by staff primarily in that context. Staff notes that the performance significance of airborne mass loadings arises from the estimation of annual intake of contaminated resuspended material. The annual intake is based on an integrated personal exposure to mass loads that can fluctuate significantly within a day and from day to day, depending on location and activity level. To address this variability, DOE relies on an approach that approximates this highly variable exposure by five standardized microenvironments defined by location and activity level (i.e., (a) outdoor active, (b) outdoor inactive, (c) indoor active, (d) indoor inactive, and (e) away). Staff examination is focused on the microenvironments with a combination of mass load, exposure duration, and breathing rate that are expected to dominate the total average daily intake of inhaled dust. In this case, the outdoor active category, and to a lesser extent, the active indoor category, are expected to be the major contributors to total airborne dust intake.

5.0 EVALUATION AND COMMENT

IA KTI Agreement 2.11 was developed to clarify the methods DOE used to estimate concentrations of potentially contaminated airborne particulates for an appropriate range of static and surface-disturbing conditions. Although staff agrees with the use of a microenvironmental approach to modeling inhalation exposure, staff had questions about specific aspects of the DOE approach. These questions were documented in a letter from the NRC to DOE (Reamer, 2004). The staff requested information on: (1) the relevance of the analog sites provided to support the parameter ranges used by DOE to the location of the reasonably maximally exposed individual; (2) whether available data indicating that walking on tephra deposits can produce elevated airborne mass loads was adequately addressed; and (3) whether short-term variations in airborne mass loads can be neglected when using 24-hour (hr) average data.

NRC staff review of the information presented by DOE is limited to a determination of whether the information provided would be adequate to support a detailed technical review.

5.1 Relevance of Literature Data from Analog Sites

After reviewing the material DOE presented, the staff concluded that the inclusion of site-specific measurements of airborne mass loads under a variety of surface disturbing activities associated with the outdoor active category, as described in sections 4.1.5 and 6.2.1.2 of the report *Exposure Input Parameters for the Biosphere Model* (BSC 2006), to corroborate literature data from analog sites provides sufficient information for a detailed review of airborne mass load estimates under nominal (non-volcanic) conditions. For potential post-volcanic scenarios, DOE has provided information from a range of the available reported literature on exposure to airborne ash following volcanic eruptions, together with analyses of the relevance of these analog sites. Staff is aware that there are only a limited number of analog sites for potential mass loadings in a post-volcanic environment. The information provided by the DOE therefore provides sufficient information to allow a detailed review of mass load estimates under post-volcanic conditions.

Staff therefore believes that by using site-specific data where possible, by evaluating a range of analog sites, and by considering the relationship between these sites and a potential post-volcanic environment at Yucca mountain, DOE has adequately addressed staff questions regarding the use of analog data to support the parameter ranges used by the DOE.

5.2 Appropriate Treatment of Dust Exposure Arising from Walking on Tephra Deposits

Regarding to the question of the exposure to airborne dust associated with walking on tephra deposits, staff concluded in a letter (Reamer 2004) that the exposure times for active outdoor conditions should include time spent by the reasonably maximally exposed individual (RMEI) walking outdoors, or that DOE needs to support the assertion that walking on deposits does not elevate mass loads above levels appropriate for undisturbed deposits. The DOE response to this question concluded that walking in the absence of mechanical disturbance of the soil did not generate high total suspended particulate concentrations. This conclusion appears to be based on measurements obtained in the fall 2005 Desert Research Institute measurements reported in Table 6-9 of *Exposure Input Parameters for the Biosphere Model* (BSC 2006).

NRC staff understands that walking on paved or grassy surfaces is unlikely to resuspend large amounts of dust, and considers measurement #4 (associated with the undisturbed desert dirt surface) in Table 6-9 most relevant to the question of whether walking on tephra deposits can elevate mass loads. However, publicly available data in Hill and Connor (2000) and Searl et al. (2002) indicates that airborne mass loads can be elevated by a factor of ten relative to static conditions when volcanic deposits are walked on. The emphasis placed on a measurement over a non-tephra surface rather than on reported data on the effect of walking on actual tephra deposits, requires further explanation. In addition, it is not clear how activities identified in Table 6-9 of the report *Inhalation Exposure Input Parameters for the Biosphere Model* (BSC 2006) are consistent with the definition of the inactive outdoor microenvironment as defined and described in Section 6.1.1. In particular, the activity and location corresponding to measurement #4 in Table 6-9 appear similar to the activities and locations described for the active outdoor microenvironment but is assigned to the inactive outdoor microenvironment.

Staff therefore believes that either: (1) DOE needs to provide more information or analyses to support the assertion that walking on tephra deposits does not elevate mass loads; or (2) DOE needs to provide more information or analyses to demonstrate that the exposure times for active outdoor conditions includes time spent by the RMEI walking outdoors on undisturbed deposits.

5.3 Use of 24-Hr Average Data to Represent Short Time Interval Average Values

Regarding whether short term variations in airborne mass loads can be neglected when using 24-hr average data, DOE provided:

- Reference to a discussion on diurnal variability from a U.S. Environmental Protection Agency Report (EPA 2004, Section 3.2.2),
- A rationale that use of 24-hr data is appropriate because it more accurately reflects annual average concentrations (BSC 2006, Section 6.2.2), and
- Sensitivity analyses (BSC 2006, Appendix A) that address the sensitivity of the total mass inhaled to variations in input parameters across different microenvironments.

Although the rationale that the use of 24-hr data is appropriate because it more accurately reflects annual average concentrations is unclear, staff notes that the analyses and information provided in EPA 2004 (based on Fitz-Simons et al., 2000) show relatively small variations in annually averaged hourly PM2.5 measurements. In addition, because the total mass inhaled is mainly associated with the active outdoor microenvironment, relatively large variations in the inactive outdoor or indoor microenvironments would not have major effects on estimates of total daily mass inhaled. Mass loadings associated with the active outdoor microenvironment, which is expected to dominate the total daily intake, appears to rely on shorter-term measurements more appropriate for short-term exposures.

Staff therefore believes that by providing information demonstrating a relatively limited diurnal variability in airborne mass loads and sensitivity analyses showing the limited effect of large variations in outdoor inactive or indoor mass loads, DOE has provided sufficient information to evaluate whether short-term variations in airborne mass loads can be neglected when using 24-hr average data.

5.4 Summary

In summary, by using site-specific data where possible and by evaluating a range of analog sites and considering the relationship between these sites and a potential post-volcanic environment at Yucca mountain, DOE has adequately addressed staff questions about the use of analog data to support the parameter ranges used by DOE. By providing information demonstrating a relatively limited diurnal variability in airborne mass loads and sensitivity analyses showing the limited effect of large variations in outdoor inactive or indoor mass loads, DOE has provided sufficient information to evaluate whether short-term variations in airborne mass loads can be neglected when using 24-hr average data.

However, staff believes that either: (1) DOE needs to provide more information or analyses to support the assertion that walking on tephra deposits does not elevate mass loads; or (2) needs to provide more information or analyses to demonstrate that the exposure times for active outdoor conditions includes time spent by the RMEI walking outdoors on undisturbed deposits.

6.0 STATUS OF THE AGREEMENT

Based on the preceding review, staff does not agree with DOE that the information provided by DOE fully satisfies the intent of IA KTI Agreement 2.11. The information staff needs is described in Section 5.2 of this evaluation. Therefore, staff considers the status of this agreement as "needs additional information."

7.0 REFERENCES

Bechtel SAIC Company, LLC (BSC). "*Technical Basis Document No. 12: Biosphere Transport*." Rev. 1. Las Vegas,Nevada: Bechtel SAIC Company, LLC. 2003.

Bechtel SAIC Company, LLC (BSC). *Biosphere Model Report* (MDL-MGR-MD-000001 Revision 01) Bechtel SAIC Company, LLC. November 2004.

Bechtel SAIC Company, LLC (BSC). *Characteristics of the Receptor for the Biosphere Model* (ANL-MGR-MD-000005, Revision 03). Bechtel SAIC Company, LLC. September 2004.

Bechtel SAIC Company, LLC (BSC). *Inhalation Exposure Input Parameters for the Biosphere Model* (ANL-MGR-MD-000001, Revision 04). Bechtel SAIC Company, LLC. June 2006.

Fitz-Simons, T. S., Mathias, S., and Rizzo, M. (2000) Analyses of 1999 PM data for the PM NAAQS review. Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards; November 17. Available at: http://www.epa.gov/oar/oaqps/pm25/analyses.html. April 2002.

Hill, B.E. and C.B. Connor. "*Technical Basis for Resolution of the IA KTI*." San Antonio, Texas: CNWRA. 2000.

Reamer, C.W. "U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Igneous Activity (June 21–22, 2001)." Letter (June 29) to S. Brocoum, DOE. Washington, DC: NRC. http://www.nrc.gov/waste/hlw-disposal/public-involvement/mtg-archive.html#KTI> 2001.

Reamer, C.W. "Staff Review of the U.S. Department of Energy Response to Igneous Activity Agreement Items 2.11 and 2.14; Status 2.11 "Need Additional Information", 2.14 "Complete"". Letter June 14 to J. Ziegler, DOE. (ML041310155. Washington, DC: NRC. 2004. <www.nrc.gov/reading-rm/adams.html>

Searl, A., A. Nicholl, and P.J. Baxter. "Assessment of the Exposure of Islanders to Ash from the Soufriere Hills Volcano, Montserrat, British West Indies." Occupational and Environmental Medicine. Vol. 59. pp. 523–531. 2002.

U.S. EPA. *Air Quality Criteria for Particulate Matter*. U.S. Environmental Protection Agency, Washington, DC, EPA (600/P-99/002), October 2004.