November 12, 2002

Joseph D. Ziegler, Acting Assistant Manager
Office of Licensing and Regulatory Compliance
U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Yucca Mountain Site Characterization Office
P.O. Box 30307
North Las Vegas, NV 89036-0307

SUBJECT: IGNEOUS ACTIVITY AGREEMENT 2.03

Dear Mr. Ziegler:

In your letter dated June 13, 2002, the U.S. Department of Energy (DOE) enclosed a report, "Range of Tephra Volumes." This report was provided to close Igneous Activity (IA) Agreement Item 2.03. After review of this document, the U.S. Nuclear Regulatory Commission's staff does not consider that the information in referenced report adequately documents the basis for determining the range of tephra volumes that is likely from possible future volcanoes in the Yucca Mountain Region (YMR). DOE continues to use the total volume of preserved basaltic volcanoes in the YMR without adequately accounting for eroded material, and some information from analog volcanoes without providing a technical basis to support their use. DOE needs to demonstrate that tephra volume has been accounted for when using information from the eroded volcanic deposits of the YMR, demonstrate that buried lava flows have been considered, and document the technical basis for use of the analogs chosen. In addition, the apparent lack of sensitivity for this parameter in DOE performance calculations needs to be explained. Further information on these concerns is provided in the enclosure to this letter.

Staff conclude that DOE has provided insufficient information to adequately document the bases for its determination that tephra volumes used in DOE performance assessments are appropriate for representing Yucca Mountain region volcanic eruptions. Therefore, IA Agreement 2.03 is listed as "needs additional information." If there are any questions regarding this letter, please contact John S. Trapp at 301-415-8063 or by e-mail at jst@nrc.gov.

Sincerely,
/RA/

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

Enclosure: NRC review of DOE letter
pertaining to Igneous Activity
Key Technical Agreement 2.03

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OFC	HLWB	HLWB	HLWB	HLWB	HLWB
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DATE	10/29/02	10/30/02	11/04/02	11/04/02	/ /02

NRC Review of DOE Report Pertaining to
Igneous Activity Key Technical Issue Agreement 2.03

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 license 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. Also, and 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 it's 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 NRC/DOE Igneous Activity Agreement 2.03 made during the Igneous Activity (IA) Technical Exchange and Management Meeting on August 29-31, 2000, as modified during the IA Technical Exchange and Management meeting of June 21-22, 2001. By letter dated June 30, 2002, the DOE submitted a letter report entitled "Range of Tephra Volumes" to resolve the NRC concerns related to IA Agreement 2.03.

The following provides the NRC staff review of this letter report:

1) Igneous Activity Agreement 2.03

"Document how tephra volumes from analog volcanoes represent the range of tephra volumes from Yucca Mountain Region (YMR) volcanoes. DOE agreed and will document the basis for determining the range of tephra volumes that is likely from possible future volcanoes in the YMR in the Eruptive Processes AMR (ANL-MGR-GS-000001). This will be available to the NRC in FY 2002."

NRC Review: The NRC staff have reviewed the letter report entitled "Range of Tephra Volumes" dated July 29, 2002, and consider that the referenced report has not addressed the agreement item, and does not correctly represents the values that the NRC has used in analysis.

During most basaltic volcanic eruptions, magma is erupted as lava flows, scoria cones, and tephra falls. The dispersal of tephra is calculated using the ASHPLUME model (e.g., Jarzemba, 1997), which relates tephra mass-flow rates to column heights and dispersal distance. In addition, the volume of tephra determines the concentration of high-level waste in the eruption plume. Thus, tephra volume is an important parameter (i.e., NRC, 1998a) in performance calculations for potential volcanic disruption scenarios.

Tephra deposits at basaltic volcanoes in the Yucca Mountain region are highly eroded. Tephra volumes for past basaltic volcanic eruptions in the Yucca Mountain region thus cannot be calculated from field measurements. Based on comparison with analog volcanic eruptions, NRC (1998b) estimated these tephra volumes from cone-to-lava ratios preserved at Yucca Mountain region volcanoes. Analog volcanoes have tephra volumes that range from 0.012–0.44 km^3 [0.003–0.11 mi^3] (NRC, 1998b). In comparison, estimated tephra volumes for individual Yucca Mountain region basaltic volcanoes range from 0.004–0.05 km^3 [0.001–0.012 mi^3] (NRC, 1998b).

In CRWMS M&O (2000a), DOE used a range of tephra volumes from 0.002–0.44 km^3 [0.0005–0.11 mi^3] to represent a potential repository-intersecting volcanic event. This table has

been reporduced in the reference letter report "Range of Tephra Volumes". This range is derived (CRWMS M&O, 2000b) from DOE estimated preserved deposit volumes for Yucca Mountain region basaltic volcanoes (CRWMS M&O, 2000c) and analog volcano information in NRC (1999). Preserved deposit volumes (CRWMS M&O, 2000c) are an inappropriate basis for definition of realistic tephra volumes, as only some fraction of the total magma volume should erupt as tephra. The 0.002 km^3 [0.0005 mi^3] volume for Little Cones (CRWMS M&O, 2000c) also does not account for buried lava flows, which would increase the porosity-corrected volume estimate to 0.024 km^3 [0.006 mi^3] (NRC, 1998b).

In addition to the inappropriate use of preserved deposit volumes as a realistic range of tephra volumes, the DOE has not provided a technical basis to support the use of historically active basaltic volcanoes as analogs for future eruptions in the Yucca Mountain region (e.g., Connor, 1993). Although support for these analogs is provided in NRC (1998b, 1999), the DOE has not documented the basis for use of the cited volcanoes as analogs for future eruptions in the Yucca Mountain region basaltic magmatic system. Thus, DOE has not established a technical basis to support the use of 0.002–0.44 km^3 [0.0005–0.11 mi^3] for tephra volumes in performance calculations.

The DOE Range of Tephra Volumes Letter Report cites calculations CRWMS M&O (2000a) that show a lack of sensitivity in probability-weighted dose to changes in tephra volume from 0.0026 km^3 [0.0006 mi^3] to 0.336 km^3 [0.081 mi^3] (i.e., changes in eruption column height from 2 km [1.2 mi] to 5 km [3.1 mi] above ground level). This result is unexpected, as simple volumetric relationships indicate a greater than two order-of-magnitude increase in tephra volume should result in an associated dilution in the concentration of incorporated high-level radioactive waste. This may, in part, be due to the fact that the values used for wind velocities in the TSPA has not yet been corrected to obtain values that are representative of the height of the eruptive column (See IA agreement 2.09). The DOE should explain why these large variations in tephra volume do not affect dose calculations significantly. In addition, independent calculations using the NRC Total System Performance Assessment code show that the smallest conditional doses result from large-volume eruptions with low wind velocities. Thus, a range of tephra volumes that is biased towards larger volume eruptions may bias results towards lower average conditional doses.

No new information was provided in the Range of Tephra Volumes Letter Report to support the DOE tephra volumes used in performance calculations (e.g., CRWMS M&O, 2000a). In addition, DOE acknowledges that it intends to document the range of tephra volumes and the basis for that range in a future modification to CRWMS M&O (2000c). As providing this needed information was the basis to complete IA Key Technical Issue Agreement Item 2.03, staff conclude that DOE has provided inadequate information to meet this agreement. The DOE will need to document how the tephra volumes used in DOE performance calculations represent the likely range of tephra volumes from Yucca Mountain Region (YMR) volcanoes.

Status of Agreement

Staff conclude that the DOE has not acceptably addressed staff questions in Igneous Activity Key Technical Issue Agreement Item 2.03 regarding the use of appropriate tephra volumes in DOE performance calculations. IA Agreement Item is listed as "needs additional information."

Additional Information Needed: DOE needs to: (a) Provide a technical basis for demonstrating how tephra volumes have been calculated based on eroded deposits in the YMR, (b) Provide a technical basis for the inclusion of analog information, and (c) Demonstrate how buried deposits, such as the flows from Little Cones, has been incorporated into the calculation of tephra volumes. In addition, the apparent lack of sensitivity of tephra volume in performance assessment calculations should be demonstrated under appropriate wind conditions. The staff

notes that in the letter report “Range of Tephra Volumes,” the DOE stated that “DOE intends to document the range of tephra volumes and the basis for the range used to support TSPA-License Application (LA) in an update of the AMR, *Characterize Eruptive Processes at Yucca Mountain, Nevada [*ANL-MGR-GS-000002].” Completion of this report should provide the NRC with the information needed to close this open item.

References

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Jarzemba, M.S. “Stochastic Radionuclide Distributions After a Basaltic Eruption for Performance Assessments of Yucca Mountain.” *Nuclear Technology*, Vol. 118, No. 2. pp. 132–141. 1997.

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NRC. “Issue Resolution Status Report, Key Technical Issue: Igneous Activity.” Revision 1. Washington, DC: NRC. 1998b.

NRC. “Issue Resolution Status Report, Key Technical Issue: Igneous Activity.” Revision 2. Washington, DC: NRC. 1999.