February 13, 2003

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Office of Licensing and Regulatory Compliance
U.S. Department of Energy
Office of Civilian Radioactive Waste Management
P.O. Box 30307
North Las Vegas, NV 89036-0307

SUBJECT: IGNEOUS ACTIVITY AGREEMENT 2.09, ADDITIONAL INFORMATION NEEDED

Dear Mr. Ziegler:

In your letter dated June 27, 2002, the U.S. Department of Energy (DOE) transmitted a report entitled, "Wind Speed Data Appropriate for the Height of the Eruptive Columns Being Modeled," to provided the information necessary to satisfy Igneous Activity Key Technical Issue Agreement Item 2.09. As this report relies almost entirely on information provided in the Supplemental Science and Performance Assessment Report (SSPA), and as the information in the SSPA has not been obtained under an appropriate quality assurance (QA) program, the U.S. Nuclear Regulatory Commission (NRC) had not taken action on this letter until it could be clarified how this type of information was to be used by DOE leading up to submission of a license application.

NRC and DOE have had two separate meetings on the SSPA, August 2, 2001, and September 18-19, 2001. During these meetings the DOE indicated that the SSPA is not a quality-related document and that the information in the SSPA does not replace the previous quality-related documentation. Furthermore, the DOE indicated that if any supplemental information is deemed to be appropriate for incorporation in a potential license application, the information would be updated and included in a quality-related license application support document. Discussions of the QA concerns have been conducted in several of the DOE/NRC Management Meetings (i.e., Meeting of January 23, 2003), and have been discussed in the letter on *Sensitivity Studies to Resolve Key Technical Issues (KTI)*, from Ziegler to Schlueter dated December 24, 2002. This letter is in review, and NRC will provide comments at a later date. We are processing this agreement with the understanding that DOE will address NRC's comments to the December 24, 2002, letter and that all data used in the license application for the geologic repository at Yucca Mountain will be qualified and verified under the DOE QA program.

In summary, the staff considers that the information provided is insufficient to complete Agreement 2.09. It appears that DOE is now using the best wind speed data available. The methodology, however, does not appear to have an appropriate linkage between column height from a potential volcanic eruption, the diffusing volcanic eruption cloud, and wind speed at that altitude. DOE needs to clarify the specific altitudes used to derive the wind-speed distribution used in performance assessment models, and demonstrate that the altitudes used are appropriate for the range and distribution of eruption column heights being modeled by the DOE. More specifics are presented in the attachment to this letter.

NRC notes that in paragraph 2 of Section 2.3 of the June 27, 2002, letter report, DOE describes the development of an ASHPLUME report, which will provide validation of the ASHPLUME model and describe the inputs that are provided to the Total System Performance Assessment for License Application (TSPA-LA). It would appear that ASHPLUME report would be an appropriate place to resolve both the NRC staff's technical and QA concerns. At present, Igneous Activity Agreement Item 2.09 is considered 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 2.09

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NRC Review of DOE letter Pertaining to
Igneous Activity Key Technical Issue Agreement 2.09

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 (IA) Agreement 2.09 made during the Igneous Activity Technical Exchange and Management Meeting on August 29-31, 2000, as modified during the Igneous Activity Technical Exchange and Management meeting of June 21-22, 2001. By letter dated June 27, 2002, the DOE submitted a letter report on "Wind Speed Data Appropriate for the Height of the Eruptive Columns Being Modeled" which provided information DOE considered should fulfill IA Agreement 2.09.

Following are the results of the NRC staff's review of the June 27, 2002 letter report.

1) Igneous Activity Agreement 2.12

"Use appropriate wind speeds for the various heights of eruption columns being modeled. DOE agreed and will evaluate the wind speed data appropriate for the height of the eruptive columns being modeled. This will be documented in a calculation document. This will be available to the NRC in FY 2002."

NRC Review: The NRC staff has reviewed the letter report entitled "Wind Speed Data Appropriate for the Height of the Eruptive Columns Being Modeled," dated June 27, 2002, and concluded that the report did not provide the information necessary to close IA Agreement 2.09. The basis for this conclusion is as follows:

In abstraction for the volcanic eruption model particles are entrains in a rising plume, which reaches a level of neutral buoyancy in the atmosphere and begins to advect in the direction of prevailing wind (e.g., Jarzemba, 1997). A relatively small mass of particles diffuse from the eruption column during vertical ascent and settle near the vent. Most particles settle from the advecting plume as it continuously diffuses down wind.

Wind speed is one of the more significant parameters for NRC and DOE performance assessment models of a potential volcanic eruption plume (e.g., Hill et al., 1998; CRWMS M&O, 2000a). Velocity distributions for wind speeds are different for different altitude winds (e.g., CRWMS M&O, 1997), with higher altitude winds having generally higher average velocities. Analyses presented in Bechtel SAIC Company, LLC. (2001a, b) show that an increase in median wind speed by a factor of 1.6 increases the expected annual dose, at the compliance point, by a factor of approximately two relative to analyses in CRWMS M&O (2000b). Wind speed thus appears to be a risk significant parameter in the DOE performance assessment.

ENCLOSURE

Particle transport can be thought of simply as the sum of two horizontal vectors. The first vector represents the distance and direction a particle advects while the eruption cloud diffuses down wind at an altitude of neutral buoyancy. The second vector represents the direction and distance components that a particle experiences during fallout from the plume to the ground. Although this wind vector can be modeled as a single speed and direction, this parameter must give appropriate weight to the advection-diffusion component of transport. A simple average of a vertical velocity profile will not accurately represent the wind field affecting particle rise, advection, and settling from an eruption plume.

In CRWMS M&O (2000b), the DOE uses wind speeds for altitudes of approximately 0.5–4 km [0.31–2.49 mi] above ground level to model eruption plumes. For each model realization, a single wind speed is selected from a distribution of all wind speeds for all directions in this altitude range. Using the DOE minimum volcanic event power of 1×10^9 W [3.41×10^9 BTU/hr] and a maximum of 6.31×10^{13} W [2.15×10^{14} BTU/hour] (CRWMS M&O, 2000c) results in minimum and maximum calculated column height of 1.46 km [0.91 mi] and 23.1 km [14.4 mi], respectively (i.e., CRWMS M&O, 2000a). Approximately 75 percent of the modeled eruptions have column heights greater than 4 km [2.49 mi] above ground level (i.e., CRWMS M&O, 2000c). Based on available data (e.g., CRWMS M&O, 1997), staff concluded wind speeds were likely underestimated for modeled eruption columns greater than 4 km [2.49 mi] above ground level. In addition, wind speeds for altitudes of 0.5–1.5 km [0.31–0.93 mi] above ground level likely bias the overall wind-speed distribution to low values, as lower velocity winds are more prevalent at this altitude than at altitudes greater than 1.5 km [0.93 mi] above ground level.

DOE proposes to use a more representative data set than found in CRWMS M&O (2000c) for upper altitude winds from the Desert Rock Airstrip, Nevada. These data are a series of radiosonde measurements made between 1978 and 1995, from ground level to altitudes generally greater than 10 km [6.21 mi] above ground level. Staff agree that data for upper altitude winds at this location represent a reasonable approach for modeling potential volcanic eruption columns at Yucca Mountain, Nevada. Based on available information, however, staff cannot determine if DOE is deriving appropriate wind speed distributions from these data to model volcanic eruption columns.

The June 27, 2002, letter report states that “The distribution of wind speeds has been derived from data collected from *various* heights, times, and wind directions. The data represent the entire range of wind speed expected to occur at *all* altitudes during a hypothetical future volcanic eruption at Yucca Mountain [p. 2].” [emphasis added] The Desert Rock data independently available from the National Oceanographic and Atmospheric Administration (i.e., source cited in the June 27, 2002, letter report) contain many wind measurements for altitudes below the minimum height of a modeled eruption column, and above the maximum credible height (i.e., approximately 10 km [6.21 mi]) for a basaltic eruption column (e.g., NRC, 1999). DOE should clarify the specific altitudes used to derive the wind-speed distribution used in performance assessment models, and demonstrate that the altitudes used are appropriate for the range and distribution of eruption column heights being modeled by the DOE. The DOE approach also appears to bias the analysis towards lower wind speeds, as there will be unequal sampling of low altitude winds relative to the distribution of higher altitude eruption columns. This approach would be appropriate if wind speeds were uncorrelated with altitude; however,

the available data show a strong correlation between increasing altitude and increasing wind speed.

The June 27, 2002, letter report also cites analyses in Bechtel SAIC Company, LLC. (2001a, b) that evaluate the effect of wind speeds for altitudes higher than included in CRWMS M&O (2000b). These analyses, however, appear to use wind-speed data only from an altitude of 8.43 km [5.24 mi] above ground level (i.e., 30 kPa [300 mbar]) at Desert Rock Airstrip, Nevada (Bechtel SAIC Company, LLC., 2001a, section 14.3.3.5). The DOE intends to use Desert Rock Airstrip data in TSPA-LA analyses, but does not state if the wind-speed data used in Bechtel SAIC Company, LLC. (2001a, b) represent an appropriate parameter distribution for these data. DOE should clarify if only 8.43 km [5.24 mi] altitude data were used to develop the wind-speed parameter distribution in Bechtel SAIC Company, LLC. (2001a, b). If data from other altitudes were used in the distribution, DOE should specify which additional altitudes were used and demonstrate that this distribution is appropriate for the range of eruption column heights being modeled.

Additional Information Needed: The DOE needs to demonstrate that the wind speed used in performance assessment is appropriate for the height of the eruption column. The DOE should demonstrate that neglecting the effects of higher velocity winds expressed during particle rise and lateral advection does not underestimate risk. If the DOE chooses to convolve wind-speed data into a single distribution for use in performance assessment, the DOE should document how appropriate weight was given in the distribution to upper altitude winds representative of lateral advection processes typically observed in volcanic eruption plumes. The DOE wind-speed parameter distribution also should reflect the characteristics of the parameter distribution used for eruption column height, to avoid potential bias towards lower altitude wind speeds. As this information will be used in TSPA-LA, the DOE needs to provided this information in a format which meets the requirements of the DOE quality assurance program.

Status of Agreement: Igneous Activity Agreement 2.09 is considered as “Needs Additional Data.”

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. 2001a.

Bechtel SAIC Company, LLC. “FY01 Supplemental Science and Performance Analyses.” Vol. 2: Performance Analyses. TDR–MGR–PA–000001. Revision 00. Las Vegas, Nevada: Bechtel SAIC Company, LLC. 2001b.

CRWMS M&O. “Regional and Local Wind Patterns Near Yucca Mountain.” B00000000–01717–5705–00081, Revision 00. Las Vegas, Nevada: CRWMS M&O. 1997.

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CRWMS M&O. “Total System Performance Assessment–Site Recommendation.” TDR–WIS–PA–000001. Revision 00 ICN1. North Las Vegas, Nevada: TRW Environmental Safety Systems, Inc. 2000b.

CRWMS M&O. "Igneous Consequence Modeling for Total System Performance Assessment–Site Recommendation." ANL–WIS–MD–000017. Revision 00 ICN 01. Las Vegas, Nevada: CRWMS M&O. 2000c.

Hill, B.E., C.B. Connor, M.S. Jarzemba, P.C. La Femina, M. Navarro, and W. Strauch. "1995 Eruptions of Cerro Negro Volcano, Nicaragua, and Risk Assessment for Future Eruptions." *Geological Society of America Bulletin*. Vol. 10: pp. 1,231–1,241. 1998.

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