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August 20, 2002
Contract No. NRC–02–97–009
Account No. 20.01402.461

U.S. Nuclear Regulatory Commission
ATTN: Dr. John S. Trapp
Office of Nuclear Material Safety and Safeguards
Two White Flint North, Mail Stop 7 D13
Washington, DC 20555-0001

Subject: Completion of Intermediate Milestone—NRC Review of DOE Documents Pertaining to Igneous Activity Key Technical Issue Agreement Item 2.09 (IM 01402.461.274)

Dear Dr. Trapp:

Attached is IM 01402.461.274, entitled "NRC Review of DOE Documents Pertaining to Igneous Activity Key Technical Issue Agreement Item 2.09." This review provides a basis for not accepting the DOE response to staff concerns regarding the use of appropriate wind speed data in performance assessments of volcanic disruption scenarios. Staff conclude that the DOE approach continues to use a wind speed distribution that is not appropriate for the heights of volcanic eruption columns being modeled. By including wind speeds from altitudes lower than those attained by modeled eruption columns, DOE models likely underestimate the distance that particles can be transported during the modeled eruptions. This approach appears to underestimate probability-weighted dose to a reasonably maximally exposed individual for DOE performance calculations. If you have any questions, please contact Dr. Brittain Hill at 210-522-6087 or me at 210-522-5183.

Sincerely,

H. Lawrence McKague
Element Manager, GLGP

HLM:rae

Attachment

cc:					
	J. Linehan	D. Riffle	J. Schlueter	R. Codell	CNWRA Dirs/EMs (letter only)
	W. Reamer	B. Meehan	S. Wastler	J. Anderson	B. Hill
	B. Leslie	L. Campbell	C. Trottier	W. Patrick	R. Benke
	D. DeMarco	J. Greeves	K. Stablein	B. Sagar	T. Nagy (SwRI Contracts)

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NRC Review of DOE Documents Pertaining to Igneous Activity Key Technical Issue Agreement Item 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 importantly, resolution by the NRC staff during pre-licensing does not prejudge what the NRC staff evaluation of that issue will be after its 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 attachment addresses one agreement between the NRC and DOE made during the Igneous Activity (IA) Technical Exchange and Management Meeting (see letter,[1] which summarized the meeting). By letter,[2] DOE submitted information to address IA Agreement 2.09. The information submitted for this agreement is discussed below.

1) Igneous Activity Key Technical Issue Agreement Item 2.09

Summary: A Letter Report entitled "Wind Speed Data Appropriate for the Height of the Eruptive Columns Being Modeled" was submitted by the U.S. Department of Energy (DOE) to fulfill Igneous Activity Key Technical Issue Agreement item 2.09. This agreement is for the DOE use wind speeds that are appropriate for the various heights of volcanic eruption columns being modeled in the performance assessment. Based on staff review of the Letter Report and other available information, the information contained in this Letter Report does not appear adequate to satisfy Igneous Activity Key Technical Issue Agreement item 2.09. Staff conclude that the DOE approach continues to use a wind speed distribution that is not appropriate for the heights of volcanic eruption columns being modeled. By including wind speeds from altitudes lower than those attained by modeled eruption columns, DOE models likely underestimate the distance that particles can be transported during the modeled eruptions. This approach appears to underestimate probability-weighted dose to a reasonably maximally exposed individual for DOE performance calculations of the volcanic disruption scenario.

Wording of the Agreement: "Use the appropriate wind speeds for the various heights of eruption columns being modeled. (Eruptive AC-5) 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 FY2002."

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[1]Schlueter, J.R. "U.S. Nuclear Regulatory Commission/U.S. Department of Energy Technical Exchange and Management Meeting on Igneous Activity (August 29–31, 2000)." Letter (October 23) to S. Brocoum, DOE. Washington, DC: NRC. 2000.

[2]Ziegler, J.D. "Transmittal of Report Addressing Igneous Activity (IA) Key Technical Issue (KTI) Agreement Items 2.02 and 2.09." Letter (June 27) to J.R. Schlueter, NRC. Las Vegas, Nevada: DOE. 2002.

Review:

The abstraction for the volcanic eruption model entrains particles in a rising plume, which reachs 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.

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 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 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 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.

In summary, the DOE has provided insufficient information to allow independent evaluation of the wind-speed parameter used to model potential volcanic eruptions occurring at Yucca Mountain, Nevada. The proposed approach for randomly selecting a single wind speed from a range of wind speeds from ground surface to some unspecified altitude does not demonstrate that appropriate wind speeds are being used to model potential volcanic eruption columns and plumes. 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.

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(2): pp. 132–141. 1997.

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