Department of Energy
Office of Civilian Radioactive Waste Management
Office of Repository Development
P.O. Box 364629
North Las Vegas, NV 89036-8629

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OVERNIGHT MAIL

ATTN: Document Control Desk
Chief, High-Level Waste Branch, DWM/NMSS
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

IGNEOUS ACTIVITY AGREEMENT (IA) 1.02 ADDITIONAL INFORMATION NEEDED (AIN-1): U.S. DEPARTMENT OF ENERGY (DOE) POSITION ON VOLCANIC HAZARD AT YUCCA MOUNTAIN, NEVADA, AND PLANS FOR CONFIRMATORY STUDIES

References:

1. Ltr, Ziegler to Schlueter, dtd 9/26/02
2. CRWMS M&O 1996. Probabilistic Volcanic Hazard Analysis for Yucca Mountain, Nevada. BA0000000-01717-2200-00082 (Revision 0). Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19971201.0221
3. Ltr, Schlueter to Ziegler, dtd 12/19/02
4. Kotra, J.P.; Lee, M.P.; Eisenberg, N.A.; and DeWispelare, A.R. 1996. *Branch Technical Position on the Use of Expert Elicitation in the High-Level Radioactive Waste Program.* NUREG-1563. Washington, D.C.: U.S. Nuclear Regulatory Commission.

Reference 1 transmitted the DOE response to Key Technical Issue (KTI) Agreement IA 1.02. The wording of the agreement is as follows:

> "Examine new aeromagnetic data for potential buried igneous features (see U.S. Geological Survey, Open-File Report 00-188, Online Version 1.0), and evaluate the effect on the probability estimate. If the survey specifications are not adequate for this use, the action is not required.
> DOE agreed and will document the results of the evaluation in an update to the AMR, Characterize Framework for Igneous Activity at Yucca Mountain, Nevada (ANL-MGR-GS-000001), expected to be available in FY 2003."

Reference 1 describes the results of a study that examined the sensitivity of the frequency of intersection of the repository footprint by a volcanic event obtained from the Probabilistic Volcanic Hazard Analysis (PVHA) (Reference 2) to an increase in the number of buried volcanic centers in Crater Flat. The study was based on interpretation of the referenced aeromagnetic data. The sensitivity study indicated that an assumption of additional buried volcanic centers results in modest increases in the mean annual frequency of intersection of the repository. These increases, however, were not considered significant (enclosure 1).

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Reference 3 provided the results of the U.S. Nuclear Regulatory Commission (NRC) staff review of Reference 1. The NRC staff concluded that the information DOE submitted did not provide an adequate technical basis to evaluate the likely impacts of the new aeromagnetic and ground magnetic data on the volcanic hazard estimate. The NRC staff specified that additional information was needed to close Agreement IA 1.02. This resulted in KTI Agreement IA 1.02 AIN-1 (Reference 3).

The wording of the KTI Agreement IA 1.02 AIN-1 is as follows:

> "DOE will need to provide a technical basis to constrain the number and age of volcanic events which have occurred in the Yucca Mountain region, including events which may be present and undetected, and provide an analysis which considers the full range [of] this uncertainty, not just the limited range considered in the Letter Report. DOE also will need to provide an evaluation of how these magnetic data could change the conceptual basis used during the original elicitation to develop probability models and associated parameter distributions, including consideration of such things as event definitions, and dike and event lengths. As is stated in NUREG-1563, acquisition and analysis of physical data should be the primary manner in which licensing information is collected, however, other considerations may preclude such collection. If expert elicitation is used and it needs to be updated, NUREG-1563 offers several choices as to how the updating could be accomplished. In all cases, however, it should be thoroughly documented to provide a transparent view of the updating process and resulting judgements. In future work, DOE also should recognize the staff does not consider that substituting the judgement of project staff for the expert judgment of the panel as an appropriate update to an existing expert elicitation."

The sensitivity studies completed to evaluate the aeromagnetic data (Reference 1) followed the guidance in NUREG-1563 for updating expert judgments (Reference 4). This guidance is as follows:

> "To the extent practicable, any potential license application should address the significance and impact that any new information might have on the validity of all previously existing data or elicited judgments used. If the impacts are determined to be significant, then the new data and expert judgments should be updated to incorporate the new data or information, as the information becomes available."

The volcanic hazard estimate developed in the PVHA (Reference 2) and its supporting documentation, and subsequent analyses provide reasonable representations of the volcanic framework of, and volcanic hazard for, the Yucca Mountain region. This information provides adequate support for the igneous activity sections of the License Application. The following points and associated information demonstrate the sufficiency of the information for the License Application submittal:

- The PVHA provided a robust estimate of the volcanic hazard for the Yucca Mountain region.
- Temporal and spatial patterns of volcanism in the Yucca Mountain region have been evaluated.
- The sensitivity of the new information has been evaluated.
- The methods do not result in underestimation of the risk from a potential future igneous event.

Enclosure 1 provides a summary of the supporting technical information for each of these points. Enclosure 2 provides a summary of planned studies to confirm the licensing basis for the volcanic hazard. These studies include an aeromagnetic survey, drilling, sampling, and data analysis to evaluate the sources of the magnetic anomalies. If basalt is encountered by drilling, its physical characteristics, geochemistry, and age will be determined. Any new information about basalt characteristics will be evaluated for its potential effects on the PVHA results. If the evaluation has a significant effect on the hazard estimate, the appropriate sections of the License Application will be updated.

The DOE continues to consider IA 1.02 to be fully addressed by the information in Reference 1, and that it should be closed.

This letter contains one new regulatory commitment: The DOE will complete a program of field studies (aeromagnetic survey, drilling and sampling) and data analysis along with an update to the PVHA to confirm the licensing basis for characterization of the volcanic hazard for the Yucca Mountain repository. Final documentation is planned for early-Fiscal Year 2006.

Please direct any questions concerning this letter or its enclosures to Eric T. Smistad at (702) 794-5073 or Timothy C. Gunter at (702) 794-1343.

Joseph D. Ziegler, Director
Office of License Application and Strategy

OLA&S:TCG-0086

Enclosures:
1. Technical Information Supporting Closure of IA 1.02
2. Phased Analysis and Date Collection Plan

NOV 05 2003

cc w/encls:
G. P. Hatchett, NRC, Rockville, MD
D. D. Chamberlain, NRC, Arlington, TX
D. B. Spitzberg, NRC, Arlington, TX
R. M. Latta, NRC, Las Vegas, NV
W. C. Patrick, CNWRA, San Antonio, TX
H. J. Larson, ACNW, Rockville, MD
Budhi Sagar, CNWRA, San Antonio, TX
J. R. Egan, Egan & Associates, McLean, VA
J. H. Kessler, EPRI, Palo Alto, CA
M. J. Apted, Monitor Scientific, LLC, Denver, CO
Rod McCullum, NEI, Washington, DC
W. D. Barnard, NWTRB, Arlington, VA
R. R. Loux, State of Nevada, Carson City, NV
Pat Guinan, State of Nevada, Carson City, NV
Alan Kalt, Churchill County, Fallon, NV
Irene Navis, Clark County, Las Vegas, NV
George McCorkell, Esmeralda County, Goldfield, NV
Leonard Fiorenzi, Eureka County, Eureka, NV
Andrew Remus, Inyo County, Independence, CA
Michael King, Inyo County, Edmonds, WA
Mickey Yarbro, Lander County, Battle Mountain, NV
Spencer Hafen, Lincoln County, Pioche, NV
Linda Mathias, Mineral County, Hawthorne, NV
L. W. Bradshaw, Nye County, Pahrump, NV
Mike Simon, White Pine County, Ely, NV
R. I. Holden, National Congress of American Indians, Washington, DC

cc w/o encls:
C. W. Reamer, NRC, Rockville, MD
A. C. Campbell, NRC, Rockville, MD
L. L. Campbell, NRC, Rockville, MD
J. D. Parrott, NRC, Las Vegas, NV
N. K. Stablein, NRC, Rockville, MD

ENCLOSURE 1

Technical Information Supporting Closure of Igneous Activity (IA) 1.02

The U.S. Nuclear Regulatory Commission (NRC) documented (Schlueter 2002) the results of the review of a U.S. Department of Energy (DOE) letter report (Ziegler 2002) addressing Agreement IA 1.02 about the interpretation of data from a 1999 aeromagnetic survey (Blakely, et al. 2000; O'Leary, et al. 2002) and the analysis of the effects of those data on the probability of occurrence of the volcanic hazard. The NRC concluded that the information DOE provided in the letter report did not provide an adequate technical basis to evaluate the likely impacts of the new aeromagnetic and ground magnetic data on the volcanic hazard estimate and specified that additional information was needed to resolve and close Agreement IA 1.02.

Wording of the additional information needed to resolve Agreement Item IA 1.02:

> DOE will need to provide a technical basis to constrain the number and age of volcanic events which have occurred in the Yucca Mountain region, including events which may be present and undetected, and provide an analysis which considers the full range [of] this uncertainty, not just the limited range considered in the Letter Report. DOE also will need to provide an evaluation of how these magnetic data could change the conceptual basis used during the original elicitation to develop probability models and associated parameter distributions, including consideration of such things as event definitions, and dike and event lengths. As is stated in NUREG-1563, acquisition and analysis of physical data should be the primary manner in which licensing information is collected, however, other considerations may preclude such collection. If expert elicitation is used and it needs to be updated, NUREG-1563 offers several choices as to how the updating could be accomplished. In all cases, however, it should be thoroughly documented to provide a transparent view of the updating process and resulting judgements. In future work, DOE also should recognize the staff does not consider that substituting the judgement of project staff for the expert judgment of the panel as an appropriate update to an existing expert elicitation.

The principal elements of the information that the NRC stated the DOE needs to provide include: (1) a technical basis to constrain the number and age of volcanic events in the Yucca Mountain region (YMR), including events which might be present but undetected; and (2) an evaluation of how the aeromagnetic data could change the conceptual basis used during the original *Probabilistic Volcanic Hazard Analysis for Yucca Mountain, Nevada* (PVHA) (CRWMS M&O 1996) to develop probability models and associated parameter distributions.

The DOE's position is that the volcanic hazard estimate developed in the PVHA, its supporting documentation, and subsequent analyses documented in the analysis report, *Characterize Framework for Igneous Activity at Yucca Mountain, Nevada* (BSC 2003), provide reasonable representations of the volcanic framework of, and volcanic hazard for, the YMR, and are adequate to support the igneous activity sections of the License Application.

To increase the confidence in the License Application and supporting information, the DOE plans to collect additional confirmatory information. This will be provided following submittal of the License Application and will enhance confidence in the characterization (numbers and ages) of potential buried basaltic volcanoes. A program consisting of an aeromagnetic survey, drilling, sampling, and data analyses will develop information about the sources of magnetic anomalies. If basalt is encountered by drilling, its physical characteristics, geochemistry, and age will be determined.

The DOE plans to use relevant information collected since the PVHA as inputs to an update of the PVHA. If the update shows that the new information has a significant effect (Brocoum 1997) on the hazard estimate, the appropriate sections of the License Application will be updated to reflect the new information.

The following points and associated information address the sufficiency of information for the License Application submittal:

- The PVHA provided a robust estimate of the volcanic hazard for the YMR.
- Temporal and spatial patterns of volcanism in the YMR have been evaluated.
- The sensitivity of the frequency of intersection to new information has been evaluated.
- The DOE's methods do not result in underestimation of the risk from a potential future igneous event.

Technical information related to each point is provided in the following discussion.

The PVHA provided a robust estimate of the volcanic hazard for the Yucca Mountain region.

The *Probabilistic Volcanic Hazard Analysis for Yucca Mountain, Nevada* (PVHA) (CRWMS M&O 1996) is a formal expert elicitation conducted in accordance with applicable guidance for such studies (e.g., Budnitz et al. 1997; Kotra et al. 1996), and the results of the analysis provide a technically defensible and robust basis for the License Application. The focus of the PVHA expert elicitation is the quantification of the conceptual model and parameter uncertainties that have significance to the annual frequency of intersection.

Sensitivity analyses conducted subsequent to the completion of the PVHA and using the License Application footprint have shown that the range of annual probability estimates (approximately 10^{-7} to 10^{-10} per year) and the mean of that range (approximately 1.7×10^{-8} per year; BSC 2003, Section 7) are relatively insensitive to postulated alternative spatial or temporal models. Given the uncertainty factored into the PVHA by assessment of alternative event counts and hidden-event factors, small changes in the PVHA event counts have an insignificant impact on the mean annual frequency of intersection derived from the PVHA.

For the PVHA, a panel of ten widely-acknowledged experts participated in a series of workshops and field trips aimed at familiarizing them with the full range of alternative viewpoints regarding the spatial and temporal models for volcanism in the region. Proponents of alternative, and often conflicting, technical positions regarding the ages of features, the number of volcanic events, geochemical affinity of features, homogeneous and nonhomogeneous spatial and temporal models, and uncertainties in the timing and frequencies of past events were participants in the workshops and field trips as well.

The PVHA experts combined multiple alternative conceptual models into a composite distribution to express the uncertainty of the informed technical community about the appropriate conceptual models of volcanism for the YMR. The PVHA experts were informed of alternative conceptual models during workshops and other structured interactions, and these were considered by the experts in constructing their weighted alternatives for temporal and spatial models of volcanism. As required by formal elicitation processes, the ten experts specifically served as "evaluators" of these alternative viewpoints and quantified the uncertainties associated with the alternatives. These quantified uncertainties, aggregated across the entire panel of ten experts, provide the fundamental underpinnings for the probability distribution on intersection frequency stated in the PVHA. Results of additional sensitivity studies have reinforced the results of PVHA.

The main consideration in the framework model of volcanism in the YMR is the recurrence or rate of volcanic events. The key parameter for estimating event rates is an estimate of the number of volcanic events that have occurred in the YMR, particularly since the Miocene ($\leq$ 23 million years ago). Because post-Miocene volcanic centers observable at the surface in the YMR have been identified, the only factor that could significantly change the PVHA's estimates of event counts and the event rate would be evidence, not considered by the PVHA, of a significant number of previously unidentified buried volcanic centers or intrusions. The effect of such buried volcanic centers on the probability of repository intersection by a basaltic dike would depend, in turn, upon the distance and location relative to the repository (because basaltic dikes are assigned distributions for lengths and azimuths; not all dikes will reach the repository) and upon the geologic age of the buried event (because different weights are assigned to different time periods, with greatest weight given to 0-5 million-year-old events).

On the basis of evidence for additional buried volcanic centers presented in Connor et al. (1997) the DOE conducted sensitivity analyses (Brocoum (1997) to assess the potential impact on the PVHA results of increased event counts in Amargosa Valley and Crater Flat. Considering the experts' methods for assessment of event counts, particularly for northeast alignments of vents (as in the case of Amargosa anomaly F/G), the mean value for the number of buried volcanic centers was increased from the original PVHA value of 4.7 events to 6.1 events (Brocoum 1997). The mean annual frequency of intersection of a dike with the proposed repository footprint was recalculated using the revised event count distributions, resulting in an increase in the mean annual frequency of intersection of 4 percent (Brocoum 1997). Given the uncertainty factored into the PVHA by assessment of alternative event counts and hidden-event factors, small changes in the PVHA event counts have a minimal impact on the mean annual frequency of intersection derived from the PVHA.

A later sensitivity analysis presented by CRWMS M&O (1998, Chapter 6, pp. 6-83 and 6-84) conservatively assumed that all known aeromagnetic anomalies in Crater Flat and the Amargosa Valley were of Quaternary ($\leq$ 2 million years old) age, rather than Pliocene ($\leq$ 5 million years old). Using this assumption, the most likely number of Quaternary volcanic events near Yucca Mountain based on PVHA event counts was increased from 3.8 to 8 events. This increase in the Quaternary event count resulted in a mean disruption probability of $\sim 2.5 \times 10^{-8}$ per year (CRWMS M&O 1998 [105347], Chapter 6, p. 6-84), a result not significantly different from the mean PVHA result of 1.5×10^{-8} per year (CRWMS M&O 1996, pp. 4-10, 4-14). It should be noted that the sensitivity analysis described in the *Synthesis of Volcanism Studies for the Yucca*

Mountain Site Characterization Project (CRWMS M&O 1998) did not repeat the PVHA analysis (CRWMS M&O 1996) using different parameters.

Temporal and spatial patterns of volcanism in the Yucca Mountain Region have been evaluated.

Sensitivity studies (Brocoum 1997; CRWMS M&O 1998) show that the addition of several volcanic events located within defined volcanic source zones does not significantly impact the results of the PVHA. In addition, the four anomalies east of Yucca Mountain (Magsino et al. 1998, Figure 1-1) show no evidence of buried volcanic centers and provide confirmatory evidence that the volcanic source zones specified by the experts to the south and west of Yucca Mountain are a valid representation of the spatial distribution of post-Miocene volcanism in the YMR.

Observations (Sawyer et al. 1994) in the Southwestern Nevada Volcanic Field (SWNVF), which includes the YMR, show that igneous activity is characterized by a pattern of declining volume through time (CRWMS M&O 2000a, p. 12.2-8). Approximately 99.9 percent of the volume of the SWNVF erupted between 15 and 7.5 million years ago (BSC 2003, Section 6.2). This volume consisted of silicic ash flow and ash fall tuffs that compose the volcanic host rock at the proposed repository. Based on comparisons with the geology of similar systems in the Great Basin, the silicic volcanism cycle is complete, and there is no suggestion that it will recur (DOE 1998, Section 2.2.7.1).

The last 0.1 percent of the eruptive volume, consisting entirely of basalt, erupted during the last 7.5 million years (BSC 2003, Section 6.2). Considered in terms of total eruption volume, frequency of eruptions, and duration of volcanism, the YMR is one of the least active basaltic volcanic fields in the western United States (BSC 2003, Section 6.2). Furthermore, studies of basalt geochemistry (e.g. Fleck et al. 1996, Figure 4, p. 8223; Perry and Crowe 1992, p. 2359) have shown that the magma generation rate in the region decreased during the Quaternary. This pattern is consistent with an overall trend of waning (decreasing) basaltic igneous activity in the SWNVF and the YMR.

The approach for calculating a recurrence rate most favored by the PVHA experts was to divide the total number of known and assumed volcanic events post 5 million years by 5 million years to get a uniform rate for that time period. At the time scale that the DOE considers appropriate for characterizing regional igneous activity, there is no geologic basis to support a model of temporal clustering, and regional observations do not support a temporal clustering model as an appropriate representation of igneous activity in the YMR.

The DOE has quantified the occurrence of Pliocene and Quaternary basalts in the YMR (CRWMS M&O 1998, p. 6-14). The significance of the Pliocene and Quaternary basalts is that the PVHA experts weighted these units more heavily in the models that were used to develop the frequency of intersection of the potential repository by a basalt dike. The Igneous Consequences Peer Review Panel (Detournay et al. 2003, p. 13) agreed that basaltic, rather than silicic, magmatism represents the most likely igneous event in the YMR and that the record of the Pliocene-Quaternary volcanic history of the Crater Flat Volcanic Zone is most relevant to possible activity in the future.

The NRC staff has suggested that a new period of volcanism in the region could have been initiated. The suggested new period of volcanism is characterized by increasing basaltic volcanic activity. In this model, the frequency of intersection developed in the PVHA underestimates the volcanic hazard at Yucca Mountain. The proposed new period of waxing (increasing) volcanism is based on the occurrence of the Lathrop Wells volcano, which is the largest and the youngest of the volcanoes in Crater Flat. The next youngest volcanoes in the region occur at Sleeping Buttes, 50 km to the northwest of Lathrop Wells. The Sleeping Buttes volcanoes erupted between three and four hundred thousand years ago, indicating that volcanic activity has not been strongly clustered either temporally or spatially near Yucca Mountain in the recent geologic past. In addition, the interpretation of waxing volcanism is not supported by the PVHA results because most experts used homogeneous temporal models within their selected time periods of interest. That is, the volcanic rate (number of events per year) was constant within each discrete period. In addition, a model of waning volcanism in the region is strongly supported by a well-documented pattern of decreasing eruption volume through time. The pattern of decreasing eruption volume spans the last 11 million years and is coincident with a trend of waning crustal extension rates in the Crater Flat basin (Fridrich et al. 1999, p. 207). This long-term pattern of volcanism and the observed tectonics are more compelling than the single Lathrop Wells event that forms the basis for the NRC staff's interpretation.

The Igneous Consequences Peer Review Panel endorsed the principle that the history of volcanism and eruptive styles of Pliocene-Quaternary volcanoes in the Crater Flat Volcanic Zone represent the best guide to possible future activity at the repository (Detournay et al. 2003, Section 2.1.1). Basalts of the past 11 Ma in the Crater Flat basin have erupted in four episodes that together define a trend of progressively declining volume of magma erupted (Fridrich et al. 1999). Consistent with this observation, and based on the past record of volcanic events and the current understanding of tectonic processes, the most likely site of a future volcanic event, if it were to occur, is in southwestern Crater Flat (CRWMS M&O 1998, pp. 6-14) - not at the repository.

The sensitivity of the frequency of intersection to new information has been evaluated.

Consistent with the DOE procedure for conducting an expert elicitation and NRC guidance (Kotra et al. 1996), DOE has conducted several evaluations of the effects of new information on the volcanic hazard estimate. For example, based on the results of the sensitivity study (Ziegler 2002) that examined the effects of the 1999 aeromagnetic data on the frequency of intersection, the DOE does not expect that the results of investigations of aeromagnetic anomalies will have significant effects on the PVHA results (BSC 2003, p. 6.5.2). Except for the basaltic andesite of Buckboard Mesa, all of the Younger Postcaldera Basalts (~4.7 Ma to 0.08 Ma) lie within a narrow northwest-trending zone located west and south of Yucca Mountain (Crater Flat Volcanic Zone described in Crowe and Perry 1990). Geologic data show that regional patterns of volcanism migrated generally to the west and south away from Yucca Mountain during the last 10 million years. Furthermore, the geologic history of Crater Flat shows that the areas of most recent volcanism are associated with areas featuring the greatest extension in central and southern Crater Flat (Fridrich et al. 1999).

New information on the age of a buried basalt encountered in the Nye County Early Warning Hole NC-EWDP-23P in western Jackass Flats is consistent with previous DOE and PVHA expert interpretations of the geologic and volcanic history of the region surrounding Yucca Mountain. The basalt was encountered beneath alluvium at a depth of 400 m and dated at 9.48 ±0.05 million years (1 sigma) using the $^{40}Ar/^{39}Ar$ method. This result indicates that basalts buried deeply in alluvium (>300 meters depth) belong to a population of older basalts (9-11 million years old) that occur commonly throughout the Yucca Mountain region. This population of older basalts was not weighted heavily in models developed by the PVHA experts to estimate the frequency of intersection of the proposed repository by a basaltic dike, and therefore, this population has limited impact on the probability estimate. The 23P basalt is located approximately 6-7 km north of aeromagnetic anomaly B, which was previously drilled and dated at 3.85 million years. The depth to the base of the Anomaly B basalt is 160 m; hence the ages of the anomaly B basalt and the NC-EWDP-23P basalt are consistent with observed burial depths.

The DOE's methods do not result in underestimation of the risk from a potential future igneous event.

A sensitivity study of effects of the 1999 aeromagnetic data on the estimate of the frequency of intersection showed a modest increase in the frequency of intersection. The best estimate of the effect of the new aeromagnetic data on the frequency of intersection (documented in the response to agreement IA 1.02 (Ziegler 2002) showed an increase in the mean annual frequency of intersection of only about 20 percent, to about 1.9×10^{-8} per year, compared to $\sim 1.6 \times 10^{-8}$ used for TSPA-SR. The results of the study of sensitivity to alternative models for the probability of igneous activity (CRWMS M&O 2000b, Section 5.2.9.1) showed that dose scales approximately linearly with probability. Based on that result, the DOE would expect the mean annual dose from an igneous event to increase by about 20 percent to about 0.11 mrem/year. An analysis based on an extremely unlikely scenario, featuring the hypothetical presence of five additional volcanic centers in Crater Flat and nine centers in Jackass Flats, showed an increase of approximately five times in the mean annual frequency of intersection to $\sim 8 \times 10^{-8}$. Even for this extreme case, the resulting probability was less than the 10^{-7} per year value that DOE has agreed to evaluate to address agreement IA 1.01.

All of the sensitivity studies done since the PVHA have consistently shown results that are within the range of $\sim 10^{-9}$ to $\sim 10^{-7}$ per year, which has been described as a reasonable range by the Advisory Committee for Nuclear Waste (ACNW 2001, p. 2). Furthermore, for volcanic activity, the ACNW noted that there was "no reason to expect changes that would fundamentally alter the current conclusions of the DOE's performance assessment results" (ACNW 2001, p. 2). Based on the results of the DOE sensitivity studies, and the results of the 10^{-7}/year sensitivity study (per agreement IA 1.01 and documented in CRWMS M&O 2000b, Section 5.2.9.1) and supported by the ACNW letter (ACNW 2001, p. 2) the DOE does not expect that the License Application submittal would underestimate the risk from a potential future igneous event.

The volcanic hazard estimate developed in the PVHA (CRWMS M&O 1996) and the supporting documentation provide reasonable representations of the volcanic framework of, and volcanic hazard for, the YMR and are adequate to support the igneous activity sections of the License Application.

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ENCLOSURE 2

Phased Analysis and Data Collection Plan

The following plan has been developed to enhance confidence in the results of the *Probabilistic Volcanic Hazards Analysis for Yucca Mountain, Nevada* (PVHA) (CRWMS M&O 1996) and information provided to support the License Application (LA). The phased plan will provide information to address the U.S. Nuclear Regulatory Commission's (NRC) request for additional information related to agreement IA 1.02 (Schlueter 2002). The information developed will constrain the number, location, age, and geochemistry of buried volcanoes and will be used as input to an update of the PVHA. The plan was initiated in Fiscal Year (FY) 2003 and will continue through three phases. Phase 1 will be completed prior to submittal of the License Application. Phase 2 will begin prior to the License Application with preliminary results available during FY 2005. Phase 3 is planned for completion during the NRC staff review of the License Application with final documentation to be available in early-FY 2006. Phases 2 and 3 are planned studies to confirm the licensing basis for the volcanic hazard.

Phase 1:

- Recalculate the probability of intersection of the LA repository footprint by an igneous event.
- Evaluate the effect on repository performance of assuming a probability of igneous disruption of 10^{-7}/year, which is near the upper end of the PVHA range of hazard probabilities. Per agreement IA 1.01, this analysis is for information purposes only and is not an element of the Yucca Mountain licensing basis.
- Develop plans for continued scientific investigations to identify and characterize potential buried volcanic centers.

Phase 2:

- Conduct a new high-resolution aeromagnetic and electro-magnetic survey of Crater Flat, western Jackass Flats, and the Yucca Mountain repository area, and analyze results.
- Initiate a staged drilling and sample analysis program. Drilling sites will be prioritized based on known aeromagnetic anomaly locations that have the highest potential impact on the probability of intersection of repository drifts by igneous intrusion or on parameters that impact the probability.
- Develop plans to update the PVHA.

Phase 3:

- Complete additional drilling and sample analysis.
- Document the results of the field and laboratory investigations.

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