SUMMARY HIGHLIGHTS OF THE U.S. DEPARTMENT OF ENERGY/U.S. NUCLEAR REGULATORY COMMISSION TECHNICAL EXCHANGE ON IGNEOUS CONSEQUENCES PEER REVIEW REPORT RECOMMENDATIONS AND IGNEOUS ACTIVITY PROBABILITY

INTRODUCTION

On Tuesday, July 1, 2003, the U.S. Department of Energy (DOE) and U.S. Nuclear Regulatory Commission (NRC) staff conducted a Technical Exchange in Las Vegas, Nevada, in which DOE presented its approach to addressing NRC staff information needs associated with Key Technical Issue (KTI) Igneous Activity (IA) Agreement 1.02. The DOE presentations covered the following: 1) a summary of the status of KTI (IA) Agreement 1.02, 2) the impact of potential volcanic events on the mean annual probability of dike intersection with the repository footprint, 3) planned field and laboratory investigations, 4) aeromagnetic survey design, and 5) status of response to the igneous consequences peer review comments. The KTI Agreement is focused on the examination of aeromagnetic data for potential buried igneous features and the evaluation of the effect of these data on the existing mean annual probability estimates.

The NRC goal of issue resolution during the pre-licensing period is to assure that DOE has assembled enough information on a given issue for NRC to accept a license application for review. The additional work planned by DOE covers information that NRC staff expects would be needed during the review of a license application (if submitted) to dispose of high-level radioactive waste at Yucca Mountain, Nevada, in accordance with the requirements of 10 CFR Part 63.

The detailed agenda for this meeting can be found in Attachment 1. The Technical Exchange included an audio connection at NRC in Rockville, Maryland. In addition to staff from DOE, NRC, the Center for Nuclear Waste Regulatory Analyses and DOE's contractors, the meeting was attended by representatives from the State of Nevada; Clark, Nye, and Lincoln Counties, Nevada; Nevada Nuclear Waste Task Force; the Nuclear Waste Technical Review Board; the United States Geological Survey; State University of New York, Buffalo; Colorado School of Mines; and the public. Attachment 2 contains the list of attendees who were present at the conference locations.

OPENING REMARKS

The meeting commenced with opening remarks by DOE and NRC. DOE indicated that the purpose of the technical exchange was to discuss the chronology of issues related to IA Agreement 1.02, the status of what will be provided in a license application, and its path forward to increase the confidence in the technical basis and address the NRC staff's need for additional information. The NRC stated that they wanted to get clarification on DOE's path forward and how the collection of these new data would affect existing probability models for igneous disruption of the potential repository site.

PRESENTATIONS AND DISCUSSION

At the meeting on July 1, 2003, DOE presented a summary of KTI Agreement IA 1.02 issues, a summary of sensitivity analyses, and a description of the planned field and laboratory program and a status on its response to comments from the Igneous Activity Peer Review Panel. The presentations included discussions on:

- Summary of Background and Issues
- Analysis of the Frequency of Intersection of Potential Volcanic Events
- Planned Field and Laboratory Investigations
- Aeromagnetic Survey Design, and
- Status of Response to Igneous Consequences Peer Review Comments

A copy of these presentations is included as Attachment 3.

Summary of KTI Agreement 1.02

A summary of the background, status, and path forward associated with the KTI agreement IA 1.02 was presented by DOE. DOE described the technical basis for the issue, and indicated that new work was planned on the issue, including 1) a low-altitude, high resolution aeromagnetic/electromagnetic (EM) survey, and 2) phased drilling program together with laboratory testing and data analysis. Upon completion of the field program, DOE would update their existing probabilistic volcanic hazards assessment (PVHA) starting in fiscal year 2005 (FY05) with final documentation available in FY06. DOE also stated that this work is included in the current draft of the performance confirmation plan, and is therefore confirmatory in nature.

NRC questioned if new data would be available for the submittal of the License Application (LA). DOE indicated that new results would be included in the submittal, although not all drilling and analyses may be completed by LA submission. However, the NRC staff stated that aside from the new DOE sensitivity analysis presented in this technical exchange (significance of potential centers in Crater and Jackass Flats and a single point dose calculation at an annual probability of 10^{-7}) that they didn't see anything different from what was provided in the KTI agreement response to IA 1.02. NRC stated that the additional information needs related to IA 1.02, which includes the current PVHA, may not be satisfied prior to submitting a license application. DOE indicated that what they were doing is building off of the existing PVHA, and they felt that the outlined sensitivity studies bounded the probability estimates. NRC staff reiterated concerns raised in its letter response to KTI Agreement IA 1.02 [December 19, 2002, letter from Schlueter (NRC) to Ziegler (DOE)], focusing on, for example, the need for additional consideration of the existing uncertainties and their potential effects on PVHA conceptual models. DOE agreed to give these concerns additional consideration in their LA planning process.

Volcanic Events and Sensitivity Studies

The frequencies of disruptive volcanic events and their significance were discussed by DOE. DOE indicated that the models were re-run to compute the frequencies, and that annual frequencies of intersection of volcanic events with the current LA footprint were slightly modified from the original PVHA. DOE then described additional analyses that considered the effects

on probability of intersection of hypothetical events in Crater Flat, Amargosa Valley, and Jackass Flats. Results indicated a potential increase (i.e., approximately a factor of five) in the mean annual probability if the potential events were realized.

NRC questioned how the DOE is using the information from its sensitivity studies to inform the decision process. DOE indicated that there is a procedure for expert elicitations, and when data becomes available, a sensitivity analysis may be conducted to evaluate the potential impact of new data on the expert assessments and to determine if it is necessary to update the elicitation. However, DOE noted that the sensitivity analysis employed the same event count method, and the same grouping of known events as the PVHA. DOE went on to say that the sensitivity analysis was completed to evaluate the effect of uncertainty on the PVHA conclusions.

During the presentation, the NRC questioned why panel four from a previous design of the repository footprint was not shown. DOE indicated that the layout has been discussed since the beginning of the year and presented in earlier meetings (e.g., DOE/NRC Technical Exchange on May 6-8, 2003). DOE went on to state that the configuration using the present waste package spacing is sufficient for the footprint as shown, therefore, the area of the former panel four is not required.

Field and Laboratory Program

Additional planned field and laboratory investigations were described by DOE. A higher resolution aeromagnetic survey was described, focusing on the "noisy" (high amplitude, short wavelength magnetic signal) region. The survey area covers the northern portion of the Yucca Mountain region.

Prior to, and possibly following the aeromagnetic survey, a limited number of boreholes will be drilled to determine the characteristics of the anomalies. The precedence of the boreholes is based on the impact to the probability estimates (such as distance to the repository and impact on event lengths). Selection of the boreholes also considers a balance of high versus low confidence anomalies. Planned laboratory work will also be conducted and will include dating and analysis of major and trace elements, and isotope geochemistry of recovered basalt samples.

Reference was made to the assumption that the basalt at the Nye County well (#23p) is approximately 10 million years in age. The NRC questioned the basis of the assumption on the Nye County well basalt and how this would be verified. DOE described the depth of the basalt as the basis of the age estimate, and stated that the basalt would be dated as part of the planned laboratory program to confirm the assumption.

Aeromagnetic Survey Design

DOE described the objectives, concepts and parameters involved in the design of an aeromagnetic survey in the area. DOE indicated that a low-level survey will provide greatly improved spatial resolution compared to typical airborne surveys, and can provide more uniform coverage in uneven terrain. The program will collect multi-frequency electromagnetic (EM) data (in the range of 300 Hz to 100 kHz) along with the total magnetic field. The present plan for

the survey indicates that it will be flown at 30-meters above the surface (conducted by helicopter) and is expected to provide good resolution of smaller sources. The survey lines, as presented, would be conducted at 60-meter spacing with perpendicular tie lines flown at the same altitude but at greater spacings. DOE indicated that survey relies on the magnetic difference between the tuff and the basalt. Resolution is expected to be less in the noisy areas, and detection below 200 meters will be more difficult in the noisy areas.

Discussion of Field Program and Aeromagnetic Survey - DOE/NRC

Timing and Targets of the Survey

While NRC agreed with the content of the program, questions were raised on the timing of the program. It was not clear to the NRC how the existing site characteristics were used in the survey design. In addition, the NRC suggested that the survey's priorities and target(s) were unclear. Also, the NRC questioned what data the DOE had reviewed and analyzed to prepare the groundwork for the program. NRC requested that the DOE quantify the detection limits both spatially and vertically and appropriate calculations should be performed. As part of the discussion, the NRC staff asked the following questions relating to the design of the aeromagnetic surveys:

- Could DOE collect specific petrophysical data from the basalts, such as magnetic susceptibility, remanent intensity, and conductivity, that would better characterize these rocks? These data are necessary to accurately quantify the detection limits (both horizontal and vertical) of the aeromagnetic and EM surveys in both the magnetically noisy and quiet areas. Susceptibility and remanence data of the basalts will also help DOE optimize the planned surveys to minimize uncertainties in the results.

- Could DOE better define the expected targets of the surveys, in terms of shape, depth, and size in order to set reasonable expectations of the survey results? These constraints will help quantify appropriate details of the surveys such as line spacing, line orientation, and frequencies of the EM.

- Would DOE consider additional geophysical methods such as detailed gravity surveys to further reduce uncertainties in the aeromagnetic/EM results?

- Has DOE developed criteria on how deep the planned boreholes will penetrate basalt once encountered in the subsurface? Will DOE simply sample the top of flows or will they penetrate the full thickness of the flows?

DOE indicated that it understood the staff concerns and that they would take them into consideration as they continued their survey planning. However, with respect to the NRC staff's question regarding whether boreholes will penetrate basalt once encountered, DOE stated that if they encounter basalt while drilling that they would drill until they penetrate the full thickness of the basalt, unless it is determined that the borehole is following a volcanic conduit. DOE stated that the larger question is at what depth will drilling end if basalt is not encountered, and DOE is still developing those criteria.

Quantification of Uncertainty

NRC expressed the concern on how the program will provide data for the LA. From the current schedule, it appeared that there would not be additional data or change in DOE's approach for initial LA submittal. DOE responded that the LA submittal would be based on the PVHA results supported by additional sensitivity analyses at an annual probability of intersection of 10^{-7} that bounds the expected probability range. DOE also stated that results from the aeromagnetic survey and several age datings of basalts should be available prior to LA submission. An update of the PVHA will not be available for the initial submittal but will be convened to confirm the present analyses. The DOE believes that the available information is sufficient to meet the criteria of the regulations. The NRC staff disagreed with this statement. The NRC asserted that the 10^{-7} annual probability is not a bounding number and that the full range of uncertainty has not been considered. DOE indicated that the sensitivity analysis is based on fairly extreme assumptions that result in an annual probability of intersection of less than 10^{-7}. Based on current analyses, DOE feels confident that new studies will not increase the probability to more than 10^{-7}/year.

NRC staff stated that the central guidance of the regulations is on the uncertainty. NRC staff concluded that no expert on the PVHA panel felt confident to speculate on temporal clustering based on the 1995 information. The NRC staff also stated that there is a reasonable expectation that the models will change with the additional information obtained after the PVHA. For example, the new information or uncertainties could lead to consideration of a temporal clustering model. The DOE must consider the question of what appropriate igneous recurrence rate is applicable to the 10,000 year postclosure period.

NRC staff stated that reconvening the PVHA panel to evaluate the uncertainties in, for example, temporal clustering could be a way to quantify the uncertainty prior to submittal of a license application. The uncertainties could then be addressed by the field program. NRC also mentioned that other methods could also be used to address this uncertainty.

Status of Responses to Igneous Consequences Peer Review Comments

DOE presented a summary of the igneous consequences peer review. The peer review concluded that the overall conceptual model (i.e., rising dike with a pyroclastic eruption conduit) is both adequate and reasonable. In addition, the peer review panel does not recommend any alteration to the present model. However, 29 comments were noted, and responses will be prepared by DOE within a few months of this technical exchange. The review recommended that future modeling should focus on developing a more detailed model for dike/drift interaction and that the dog leg scenario should be further quantified.

DOE indicated that the current analysis model report includes issues such as pressuring the drift, considering a joint a distance down the drift from the intrusion and how the magma would interact with the joint. DOE noted that while modeling the specific mechanics of the magma is beyond DOE's current technical capabilities, a conservative approach on consequences has been taken. The current approach assumes that magma enters and fills the entire drift and that all waste packages contacted by magma fail. The DOE also stated that backfill is being considered by DOE at the intersection of the access and emplacement drifts.

CLOSING REMARKS

In closing, the DOE stated that it appreciated the candor of the NRC staff. DOE stated that it is confident with the outcome of the sensitivity analysis as conducted as it is consistent with the original PVHA. Further, DOE stated that the field program can be considered confirmatory as they don't foresee any significant changes in the results of the work completed to date. Also, DOE confirmed the statement by the NRC that a meeting on the subject of the surveys would be beneficial prior to conducting the survey.

In closing, the NRC stated that they are cautiously optimistic about the results of the program and look forward to more discussions on this matter. The NRC reaffirmed its desire to have more interactions with DOE regarding the planning of the surveys and the possible update to the DOE PVHA. With respect to the aeromagnetic and EM surveys the NRC suggested an additional meeting to further discuss the mechanics of the survey and to get DOE responses to questions regarding the expected outcome of the surveys. Also, the NRC staff suggested that the purpose of any meeting concerning convening a PVHA panel would be to discuss and resolve any process issues prior to conducting the panel.

PUBLIC COMMENTS

There was opportunity for questions and comments during the presentations as well as at the completion of formal presentations. At the end of the first presentation a member of the audience queried on how the new PVHA panel would be selected. DOE stated that the decision is being reviewed. In addition, a limited number of other comments were made by interested parties and members of the public. These comments ranged from the need for 3-D modeling, the difficulty in modeling magma flow within the drift given the heterogeneity of the country rock, and the need for stratigraphical data that could be gathered from the boreholes drilled during the field program.

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