

February 7, 2006

Dr. Michael T. Ryan, Chairman
Advisory Committee on Nuclear Waste
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Ryan:

SUBJECT: REVIEW OF THE NRC PROGRAM ON THE RISK FROM IGNEOUS ACTIVITY AT THE PROPOSED YUCCA MOUNTAIN REPOSITORY

Your letter of December 9, 2005, "Review of the NRC Program on the Risk from Igneous Activity at the Proposed Yucca Mountain Repository," provided observations and recommendations regarding analyses and investigations of potential igneous activity at Yucca Mountain.

Enclosed, please find the staff's response to your letter. The staff will keep the Committee informed regarding the results of activities in these areas and the application of risk insights.

Sincerely,

/RA/

Luis A. Reyes
Executive Director
for Operations

Enclosure:

Staff's Response to the December 9, 2005,
ACNW Letter: "Review of the NRC Program
on the Risk from Igneous Activity at the
Proposed Yucca Mountain Repository."

cc: Chairman Diaz
Commissioner McGaffigan
Commissioner Merrifield
Commissioner Jaczko
Commissioner Lyons
SECY

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**STAFF'S RESPONSE TO THE DECEMBER 9, 2005, ACNW LETTER:
"REVIEW OF THE NRC PROGRAM ON THE RISK FROM IGNEOUS ACTIVITY
AT THE PROPOSED YUCCA MOUNTAIN REPOSITORY."**

Recommendation 1. Analysis of the consequences of an igneous dike intersection with a repository drift would be better risk informed by assessing the effects of magma solidifying upon entering a drift and quenching on the waste packages and any waste released from them. These studies could have an impact on conclusions regarding the number of waste packages that could be affected by a dike intrusion and the occurrence of secondary (flank) eruptions. This in turn would impact the amount of waste distributed in a resulting ash plume, the reasonably important to the total igneous activity effects.

Understanding how rising magma may potentially interact with subsurface engineered systems has been a significant technical challenge for many years. The complex processes affecting this scenario, however, must be interpreted from few data and limited observation. Thus, models for these processes necessarily use simplified abstractions. To date, staff has used insights from first-order process models and information from analog volcanoes to develop review capabilities and understand the risk significance of potential magma-repository interaction processes. This information supports the interpretation that the waste isolation capabilities of engineered repository systems would degrade significantly if directly affected by a potential igneous event.

Staff recognizes that alternative interpretations can be made from some of the available information, which could indicate greater resiliency of engineered systems during potential igneous events. Staff appreciates the discussions with the Advisory Committee on Nuclear Waste (ACNW) on some of these alternative interpretations, and agrees that current model abstractions could be made more realistic by directly incorporating second-order processes, such as localized magma solidification and degassing effects. In staff's professional judgment, however, the magnitude and rate of these second-order processes are considerably lower than estimated by ACNW and appear unlikely to affect models significantly. To improve realism, model refinements under consideration include abstractions for thermal and degassing effects, simulation of engineered material performance during igneous conditions, and advanced multiphase flow processes. The staff will keep ACNW informed about the results of efforts to provide improved realism in magma-repository models and understanding of the potential risk significance.

Recommendation 2. The parameters and assumptions presented to date regarding the exposure scenario associated with igneous activity appear reasonable. However, in order to be adequately prepared for the license application review, the NRC staff should integrate all risk-significant aspects of the scenario by clearly justifying the processes, parameters and their values, and assumptions. The Committee believes the staff should use risk-informed approaches, including sensitivity studies, and other techniques to study and justify its choices.

The staff appreciates the support from ACNW regarding the use of analog volcano data to evaluate exposure scenarios for potential igneous events. Staff continues to use risk information to guide model development and data collection, which

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was the same approach used to prioritize the original technical investigations. Discussions with ACNW have helped focus staff explanations of the complex technical basis supporting the igneous exposure models and associated data. Although many aspects of this integrated approach are presented in the Risk Insights Baseline Report, Integrated Issue Resolution Status Reports, and numerous technical reports, additional reports are in preparation to document ongoing investigations, including documentation supporting an update to the NRC Total System Performance code. NRC staff believes that these documents will provide the ACNW with the requested information, and will make these documents available as they are completed.

Recommendation 3. The NRC staff should reevaluate the use of a single value for probability of a volcanic intersection of the proposed Yucca Mountain repository, and should consider a range of estimates on the order of $10^{17}/\text{yr}$ to $10^{18}/\text{yr}$ based on studies published by NRC and previous ACNW views. If the staff decides to use a single-point value approach, the staff should document how this decision will support a risk-informed review of the consequences of an igneous event in a potential license application. Further evaluation of this range of probabilities should include consideration of new information being assembled for, and the results of, DOE's ongoing expert elicitation on Probabilistic Volcanic Hazard Assessment.

Available probability estimates for the likelihood of future igneous events at the potential repository site span several orders of magnitude above and below the $10^{18}/\text{yr}$ level of regulatory significance. Most of this variation arises from the use of alternative conceptual models to represent the timing and location of past igneous events. Many of these models use mutually exclusive assumptions, which staff will need to review. Multiple approaches are available to evaluate alternative conceptual probability models, each of which provide different technical insights and information on risk significance. The staff also recognizes the need to evaluate different types of uncertainties between short- and long-term probability estimates.

Event probabilities from alternative conceptual models can be sampled as a range of values. Utilizing a range of values from these models propagates a measure of model uncertainty through the performance calculation, and provides insight on the effects of model variability on the average calculated risk. The basis for selecting or weighting a range can be subjective. Additionally, a sampled-range approach can confuse important distinctions between data uncertainty [i.e., 10 CFR Part 63.114(b)] and model uncertainty [i.e., 10 CFR Part 63.114(c, g)], which staff will need to assess. As an alternative, the significance of alternative conceptual probability models can be evaluated as single values in performance calculations. By using a representative probability value as a baseline in calculations, staff can evaluate the risk significance of any available probability value by simple comparison to the baseline value. Staff continues to evaluate new data and conceptual models for igneous event probabilities developed by DOE and other scientists, as well as DOE's ongoing expert elicitation on Probabilistic Volcanic Hazard Assessment and associated field and laboratory investigations. The potential risk significance of this new information can be determined and communicated by using a combination of review methods. We look forward to continuing our dialog with the ACNW on this topic.