MEMORANDUM

TO: William J. Hinze
Advisory Committee on Nuclear Waste
Nuclear Regulatory Commission

FROM: Kenneth A. Foland, Consultant

DATE: 4 May, 1997

RE: Comments on the Yucca Mountain volcanism issues at the 91st. ACNW meeting

With this report, I pass along comments and observations on the Yucca Mountain volcanic hazards issues that were the topic of the first day of the 91st. Advisory Committee on Nuclear Waste (ACNW) meeting on April 22, 1997. Because I have relayed most of these during discussion during the second day of the meeting and have expressed them orally, I will not devote extensive effort on amplification. I trust that these comments will be useful to Committee considerations and that you, other ACNW members, or the staff will call on me if follow up or amplification is desired.

General - My perspective is that the session was a very profitable one that produced a fairly clear picture of the status of the studies and the viewpoints of both the Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE). It appears that the work on probability of the a volcanic event (magma) intersecting the Yucca Mountain (YM) block, the site of proposed repository, has basically run its course. While there is a degree of convergence among the DOE and NRC and Nevada parties evaluating volcanic hazards, some important differences remain. The results of the Probabilistic Volcanic Hazard Analysis (PVHA) project sponsored by the DOE indicate a low probability. The number which has a mean in the low 10^{-8} per year range with the total range approximately 10^{-7} to 10^{-10}. DOE is going with this number based on the pool of expert opinions and is not conducting additional site study other than updating the PVHA for new information. The Center for Nuclear Waste Regulatory Analyses (CNWRA) models indicate somewhat higher probability, perhaps by an order of magnitude. And the state of Nevada-supported individuals find even higher probability. There is apparent reluctance by the technical NRC staff to accept fully the PVHA aggregate result because of outstanding uncertainties. This difference is an important one.

The other main factor in the volcanic hazards issue is the consequences of a magmatic disputon of a Yucca Mountain repository as it is now conceived. The DOE studies on the consequences are also complete and the results are presently being organized. Their consequences studies appear to be rather restricted in scope. On the other hand, the NRC studies at the CNWRA are proceeding and have produced some preliminary results. These results suggest that the nearby (20 km) doses due to dispersal by an eruption through the repository is overall low. My impression of this work based upon the presentations and reports it that is less well developed and poorly constrained.

Some specific impressions and comments follow.

1. Apparently the most important factor in the PVHA models is occurrence of magmatic events in space and time. With the hazard being driven essentially by the rate density, this factor is key to the validity of the PVHA result. Uncertainty in this function is the major uncertainty underlying the hazard calculation. There is a relatively small number of volcanic events in the Yucca Mountain Region (YMR) over the past five million years which adds uncertainty. As well, there are some recently discovered events and there are surely unrecognized events. Characterizing more fully the record of YMR events especially those in close proximity to Yucca Mountain would reduce uncertainty.

2. The CNWRA work using magnetic surveys has uncovered features that are apparently buried intrusions or extrusions. There is indication that there are more similar features, including at least some near the YM block. The suggestion of additional centers is based upon small anomalies on the aeromagnetic surveys. Relatively quick ground survey of several of these by the CNWRA confirmed features that appear to be buried igneous events.

3. This basic situation calls for a closer examination of the geophysics in order to identify or scope the possible presence of unrecognized events. If I recall correctly, there were plans to do this in the DOE program in linking geophysics to volcanism and tectonics but this important work seems to have fallen by the side. My opinion is that it is very important to remove or reduce this uncertainty and that it is not a mammoth task at least to scope it out. In the PVHA, the experts could choose a higher count that known for events including the magnetic anomalies suspected of being volcanic centers. Still, they could not factor in any spatial distribution of these.

My specific recommendation about the volcanic hazards situation is that despite the extensive study there are still remaining uncertainties that need to be addressed. In this context, it seems to me to be premature to close out completely the igneous processes KTI. I believe that there is important confirmatory research that would prove to be highly valuable in a regulatory sense. Moreover, my opinion is that the technical staff is quite capable of carrying it out and in a position to do so to a highly satisfactory conclusion.

I outline below four research objectives. Each one is narrowly focused to address specific issues of uncertainty. None of these is an extensive effort. Quite the contrary, for each I am suggesting a "surgically" defined goal that addresses the confirming (or refuting) the DOE position on volcanic hazards. Assuming the these efforts confirm the DOE position, this work will lead to an orderly close out of this subject at this point and will have reduced uncertainty. Otherwise, it will clearly identify to aspects that require additional effort in a regulatory context.

A. Rectify the probability calculations - There are different estimates for the probability of volcanic disruption of the YM block including those of the PVHA, CNWRA, and Nevada researchers. The various approaches need to be normalized and rectified with one another. To a real extent, work of each group has gone through some significant level of peer review and thus must be given a certain degree of confidence. This exercise should explain in a simple qualitative manner the differences in result and the reasons for these. This work should build confidence in the probability calculations and highlight the model uncertainties.

B. Evaluate the effect of unrecognized igneous events - The unrecognized events (unobserved near surface dikes, buried cones and flows, etc.) in both space and time introduce significant uncertainty to the probability models. Moreover, there are suggestions that there may be a significant number of these. The uncertainty needs to be reduced because it is the biggest one and the one that most experts agree could potentially significantly change the probability estimates. There should be a focused effort to: scope the effect on probability calculations for various numbers and distributions of volcanic centers; examine existing magnetic data to estimate a potential number of such features; and, if warranted, examine such features with focused ground surveys to confirm or refute their existence as possible recent igneous features. These tasks should be partly interative.

The first part of this evaluation is to look at the baseline and to test the probability for plausible scenarios, for example, 10, 50, or 100 more centers. In other works, do a sensitivity analysis to determine roughly how many unrecognized features (and where they need to be) are required to affect in a significant way the probability calculations.

The results of this exercise then should be judged in the context of the aeromagnetic data. It is important to scope out what may be there since recent work has identified additional features. The data should be processed in a manner to bring out anomalies that might reflect igneous features. All these possible features can then be used to judge the potential effect. If the analysis indicates that these potential "events" are significant, the anomalies should be field checked using the sort of procedures recently used by the CNWRA. Particular attention should be paid to areas closer to YM rather than those more distant.

C. Produce a synthesis for YM volcanism in a process context for the region - Volcanism in the YMR is important also to understanding the tectonics and needs to be integrated into a regional context. Generally, the focus of the probability exercises has been narrowly focused on just the probability, albeit there are various models for igneous processes that are input functions. A synthesis of the igneous events in the context of regional geological processes is valuable in evaluating all the models for the probability. As such it should reduce uncertainty about the models used. The CNWRA has had a program in volcanism and tectonics for several years and has extensively studied the YM volcanism in a regional context. They should be in a position to complete this task with the data now available.

D. Develop further the consequence analysis - At the present, the consequences part of the hazards analysis appear to be poorly refined. The analysis can be improved and made more sophisticated. The present situation appears to indicate low dose rates at a removed location. But, this is only one scenario of a possible disruption. There are others including those which may have the beneficial effect of isolating waste further. The full range of these need to be considered for completeness. At this point, there seems little justification for carrying out work to refine further eruptive models unless consideration of the full range of these demonstrates much higher dose possibilities. To a significant degree, the importance of the consequence analysis and its direction will be influenced by the new dose-based standard. Thus, what seems warranted is to complete the work in an orderly fashion including consideration of: alternate scenarios, types and modes of dispersal; and other indirect effects. Obviously, this is a limited effort on various issues but it forms a baseline framework for possible effects that may also relate to other dimensions of performance.