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Hydrogeology • Mineral Resources Waste Management • Geological Engineering • Mine Hydrology

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Mr. Jeff Pohle
Division of Waste Management
Mail Stop 4-H-3
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Jeff:

We believe the rate and the distribution of flux in the unsaturated zone at Yucca Mountain require additional investigation. We have discussed internally the following scenarios which we believe should be investigated using the finite element model UNSAT2. These scenarios will evaluate some basic questions associated with the consideration of flux at Yucca Mountain. The evaluation of these scenarios will assist us in our consideration of alternative conceptual models for the unsaturated zone. These scenarios were not evaluated in the previous modeling work submitted as Communication #176 (latest version). The first two scenarios could be considered sensitivity studies.

These scenarios require a smaller element size than that used in our initial modeling study (Communication #176). We are not suggesting a scale for the elements at this time. The scale will be determined based upon the construction of an appropriate finite element mesh that can be used for these scenarios. Of course, the number of elements and the number of nodes constrain the problem within the bounds of acceptable dimension statements within the program.

We believe that initially three basic scenarios should be modeled using the vertical section mode of the finite element model UNSAT2. The first scenario will apply different rates of uniform flux at the top of the cross-sectional mesh. The distribution of flux will be evaluated based on the random or assigned distribution of values of hydrogeologic properties within the mesh. We suggest that no more than three different material properties be used in this scenario.

The second scenario employs the same basic finite element mesh to evaluate the sensitivity of the model to varying angles of dip of a multilayered sequence of tuffs. At this time, the significance of dip in the unsaturated zone is not known. Dip has not been included in prior simulations. The

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distribution of hydrogeologic properties within the elements also will be allowed to vary in order to evaluate the combined effect of dip and of the heterogeneities upon the distribution of flux. At least two different rates of uniform flux will be applied to evaluate the effect of dip on the distribution of flux.

The third scenario utilizes the capability of the model UNSAT2 to accommodate varying rock moisture characteristic curves. We suggest that an attempt be made to use double porosity, fractured rock moisture characteristic curves such as those presented by R.R. Peters and E.A. Klavetter, March 1988, A Continuum Model for Water Movement in an Unsaturated Fractured Rock Mass, Water Resources Research, vol. 24, no. 3, p. 416-430. To our knowledge, this application of fractured rock moisture characteristic curves has not been attempted using UNSAT2 or a similar model.

We foresee using both randomly selected and deterministic distributions of values of hydrogeologic properties in these scenarios. The randomly selected and assigned distributions will reflect the heterogeneous distribution of values of hydrogeologic properties of the tuffs at Yucca Mountain. These distributions will not in any way reflect the actual distributions because the actual distributions are unknown at this time. We suggest using the full range of known values of hydrogeologic properties for the tuffs at Yucca Mountain. The scenarios described above will provide insight regarding the nature of those physical properties which are most important to the consideration of the amount and distribution of flux in the unsaturated zone. These scenarios do not address the role of fracture flow in the unsaturated tuffs.

Please call if you have any questions regarding the above described scenarios which we are proposing for the Yucca Mountain site. We believe modeling these scenarios will increase our understanding of flow in the unsaturated zone in Yucca Mountain.

Sincerely,

Roy E. Williams/al

Roy E. Williams

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