

May 3, 2002

Dr. English Percy, Manager  
Geohydrology and Geochemistry Element  
Center for Nuclear Waste Regulatory Analyses  
6220 Culebra Road, Building 189  
San Antonio, Texas 78238-5166

SUBJECT: COMPLETION OF INTERMEDIATE MILESTONES - IM 1402.861.200  
(UNSATURATED ZONE FLOW AT YUCCA MOUNTAIN, NEVADA: EFFECTS OF  
FRACTURE HETEROGENEITY AND FLOW IN THE NONWELDED PAINTBRUSH  
TUFF UNIT - LETTER REPORT)

Dear Dr. Percy:

The U.S. Nuclear Regulatory Commission staff has completed its review of the subject report, which was sent to us on April 18, 2002. The document was sent one day early and provides timely input to our ongoing issue resolution work. This Center for Nuclear Waste Regulatory Analysis (CNWRA) report is programmatically and technically acceptable. It evaluates several key topics in unsaturated zone (UZ) flow, including the potential development of preferential flow paths and the potential for lateral flow. The U.S. Department of Energy's (DOE) recent UZ models are reviewed and the results of independent CNWRA modeling and field studies are reported. I especially appreciate the thoroughness of this review with respect to the cited DOE reports. Other staff comments are provided in the enclosure. These additional comments do not require revision and re-submission of the milestone product, but should be considered in any future updates of this or other reports that relate to deep percolation and unsaturated zone modeling.

A key conclusion is that DOE's ranges of flow-focusing factors used in total system performance assessment are reasonably conservative given DOE's assumptions about spatial variability in fracture properties. Improved knowledge of the correlation scale for flow variability would be a good objective for ongoing tests in the UZ. I expect this knowledge will be provided by results from Alcove 8/Niche 3, passive cross-drift test, Alcove 1, and permeability testing in the tunnels.

Another key conclusion relates to lateral flow in the UZ. This topic is important because it relates to how much groundwater can move vertically through a repository, and what fraction is laterally diverted near the base of the Tiva Canyon Tuff. Field and laboratory evidence suggests that lateral flow in the UZ is limited, and that DOE should take little credit for this phenomenon. A similar conclusion was reached by a DOE expert elicitation on the UZ. The panel of experts reviewed data available up to 1996 and concluded that lateral flow might occur, but only on a scale of tens of meters.

Under the Key Technical Issue of Unsaturated and Saturated Flow Under Isothermal Conditions, this Center report relates to the subissue of present-day and future deep percolation through the repository horizon. The report focuses on one of our integrated subissues, i.e., 4.2.1.3.6 (Flow Paths in the Unsaturated Zone), which also comprises a section of the Yucca Mountain Review Plan.

If you have questions, please contact me at (301) 415-6615.

Sincerely,  
/RA/

Neil Coleman, Program Element Manager  
Division of Waste Management  
Office of Nuclear Material Safety and Safeguards

Enclosure: As stated

cc: J. Linehan  
B. Meehan  
B. Sagar, CNWRA

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B. Meehan  
B. Sagar, CNWRA

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2) This document is related to the HLW program - place in the LSS  YES

## Enclosure

### Additional Comments on "UZ Flow at YM, NV: Effects of Fracture Heterogeneity and Flow in the Nonwelded Paintbrush Tuff Unit"

Matrix heterogeneity needs further investigation and may be an important factor in determining effects on focusing seepage flow spacing for models and flow rates. We are aware that the CNWRA is planning work of this type.

p. 2-20

Second paragraph, last sentence: "Widely spaced zones of focused flow may not be as readily redistributed in the Topopah Spring unit." It would be helpful to explain why this is the case, referring to the degree of welding and spatial patterns of fracturing in the Topopah Spring.

p. 2-21

Last paragraph: "DOE performance assessments could result in overly optimistic radionuclide transport simulations because closer active-fracture spacings result in greater rates of matrix diffusion." It would be useful for us to have some graphical representations of matrix diffusion. We have seen such techniques demonstrated at Sandia National Labs.

p. 2-22

First paragraph: There is no specific NRC/DOE agreement that uses this wording, but it appears to relate to USFIC 4.01 regarding unsaturated zone testing.

p. 2-22

Second paragraph: "The stochastic simulations presented in this report do not consider possible correlations between fracture continuum and moisture-retention characteristics." It would be helpful to note whether the DOE approach considers these correlations.

p. 3-9

First paragraph: "Episodic flow through the Tiva Canyon...can saturate the fracture network... and disable the barrier (PTn)." The case is discussed for El Nino events, but should also apply to monsoonal periods proposed to occur beginning about 4,000 years after repository closure.

p. 3-19

Last sentence: "...Paintbrush Tuff does not occur ... on the west flank of Yucca Mountain." PTn does not occur on west flank of YM." Minor point is that PTn does occur on the fault scarp above the ground surface as shown on the photos on page 3-28. We note that the first sentence on 3-21 does refer to an exposure of nonwelded Paintbrush Tuff on the west flank.

p. 3-34

Second paragraph: Note that NRC/DOE agreement GEN.1.01(tracking #24) and TSPA.3.23 are related to this discussion.