UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, DC 20555 - 0001

ACNWR-0203

March 4, 2004

The Honorable Nils J. Diaz
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Diaz:

SUBJECT: INSTABILITY OF EMPLACEMENT DRIFTS OF THE PROPOSED YUCCA MOUNTAIN HIGH-LEVEL WASTE REPOSITORY

At its 146th and 147th meetings on October 22-23, 2003, and November 19-20, 2003, respectively, the Advisory Committee on Nuclear Waste (ACNW) was briefed on analyses of the stability of the emplacement drifts for the subject repository. At the 146th meeting the NRC staff presented the results of the preliminary analysis of drift instability, followed by a brief comment from a DOE staff scientist. At the 147th meeting the role was reversed: the DOE briefed the Committee on DOE's views of drift instability, while an NRC staff member offered a general comment at the conclusion of the briefing.

The Issues

The first issue is the possibility that part of the rock mass surrounding the void space in the emplacement drifts will eventually break into blocks that can drop and damage the drip shield. This is a dynamic impact problem. The second issue is the buildup of static loads of rock rubble that could lead to collapse of the drip shield, possibly resulting in damage to the waste package in the process. During postclosure, when it is no longer possible to maintain the ground support system, there is the concern that the ground support system will lose its capability to prevent the fallout and accumulation of rock in the void space. The key question is, could drip shield-waste package interactions lead to an acceleration of the failure of the waste packages during the 10,000-year compliance period?

Areas of Disagreement

An area of disagreement between the NRC staff analyses and DOE analyses relates to the time at which rock fall and rock fall rubble accumulation will become a threat to the integrity of the near-field engineered barriers, primarily the drip shield and the waste package. The NRC staff analyses suggest that seismically induced dynamic impacts of rocks might be a concern in emplacement drifts in the middle nonlithophysal rock unit (12.4 percent of the repository according to the DOE). The NRC staff analyses indicate that dynamic impact such as from large falling rock blocks is not a concern in emplacement drifts in the lower lithophysal rock unit (80.3 percent of the repository according to the DOE). Static loads are another matter. The NRC staff analyses indicate that on average 75 percent of the drip shields will buckle under static rockfall loads within 500 years after closure. The NRC analyses are based on empirical data and observations of coal mining operations.

DOE does not believe that it is inevitable that the tunnels will collapse. The drift spacing (and hence interaction) and ground support system are very different from those in mining operations. DOE believes that empirically related tunneling classification schemes that were made for personnel safety considerations are not applicable to predicting thousands of years of drift performance. DOE is using a rock mechanics model based on site characterization data to predict the collapse of the drifts. Their drift degradation model is based on three primary sources of stress: gravitational stress, thermal loading, and seismic loading. Because the stresses in the tunnel walls are in equilibrium, DOE does not expect gravity to cause rock falls. Their claim is that no significant rock falls have been observed and that there is no driver for rock falls in the future. Although some spalling has been observed as a result of the heater tests, it is considered minor. DOE does not believe that a seismic event could trigger a tunnel collapse; such an event, in their opinion, has never been observed. DOE further pointed out that many natural excavations have stood for millions of years without collapse.

NRC and DOE agree that the primary issue is the static load of rock rubble on the drip shield. Dynamic impact on the drip shield is not considered a major concern by either the NRC or DOE. DOE does not believe that the dynamic impacts of rocks will be a threat to the integrity of the engineered barriers during the 10,000-year regulatory compliance period. The NRC staff has only limited concern about dynamic rock impacts and then only with respect to the middle nonlithophysal rock unit. Two factors diminish the NRC staff's concern. The first is that only a small fraction of the repository (12.4 percent) lies in the middle nonlithophysal rock unit. The second is that the rock blocks would accumulate in the void space; once the drip shield is buried with rock rubble, subsequent rock blocks falling would be on top of the rubble and would not transfer significant mechanical load to the drip shield.

Conclusions and Recommendations

The issue of drift stability needs to be put in context with other features, events, and processes affecting repository performance. ACNW is not aware of any drift stability risk insights from either NRC's or DOE's analyses. Such risk insights should be developed.

Simple scoping models should first be applied to determine if there is a real threat to repository performance from drift collapse. To the extent practical, the modeling should reflect the actual conditions of the repository and the design of the engineered barriers. The Committee questions the appropriateness of the use of coal mining analogs and the relevance of coal mining data to the analysis.

The Committee believes it is important to quantify the impact and uncertainties of drift instability on engineered barrier performance. The Committee further believes that the near-field environment-thermal pulse, moisture flow, humidity, perturbations from operations, etc., should be considered in the analyses.

The Committee has learned of several recent design changes that may enhance emplacement drift stability. The design change most relevant to drift stability has to do with the ground support system. The major change in the ground support system is to install a 3-millimeter-thick stainless steel (type 316) liner in a 240° arc around the drift periphery along the entire drift length. The liner is anchored to the drift with friction rock bolts 3 meters long, spaced at 1.25 meters.

To the extent possible, any analyses of the impact of drift stability on repository performance should reflect realistic design considerations as well as the actual properties of the natural system.

Sincerely,

/RA/

B. John Garrick
Chairman

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