April 16, 2004

Dr. B. John Garrick, Chairman
Advisory Committee on Nuclear Waste
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

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

Dear Dr. Garrick:

I am replying to your letter, dated March 4, 2004, to Chairman Diaz that provided the Advisory Committee on Nuclear Waste's (ACNW) recommendations on the subject of potential long-term instability of the waste emplacement drifts at the high-level waste repository at Yucca Mountain, Nevada. The U.S. Nuclear Regulatory Commission (NRC) staff generally agree with the ACNW's characterization of the issue which boils down to the key question: could the drip shield-waste package interaction lead to an acceleration of the failure of the waste packages during the 10,000-year compliance period as a result of long-term drift degradation. Another component of the issue is the second key question: whether the effects of any accumulated rock rubble in the emplacement drifts, such as static and dynamic loading or temperature and relative humidity, need to be considered in the design of the engineered barriers and in the assessment of their performance. The NRC and Center for Nuclear Waste Regulatory Analyses (CNWRA) staff appreciated the opportunity to make presentations on this topic at the 146th ACNW meeting in Rockville, MD and observe the 147th meeting on the same topic in Las Vegas, NV.

The ACNW's letter, while succinctly summarizing the differences between the NRC staff and the Department of Energy (DOE), refers to the NRC analyses as based on empirical data and observations of coal mining operations. However, the NRC analyses are based on analytical models consisting of many simplifying assumptions and limited evaluations considering the possible combination of in-situ, excavation-induced, seismically induced and thermally induced stresses. Empirical data, documented observations, and other relevant experiences of underground openings, such as mines and tunnels in various rock types, have also been used. Empirical data from coal mines were cited as supporting information during the presentation to the ACNW, but they do not constitute the basis for the conclusions drawn. Predicting long-term behavior of jointed and lithophysal rocks under a combination of in-situ, thermal, and seismic stresses taking into consideration the time-dependent degradation of properties is a challenging problem to solve and requires making many simplifying assumptions and approximations using alternative conceptual models. Therefore, in spite of the state of the art methodology, significant field and laboratory testing, and use of sophisticated continuum and discontinuum models by DOE, some differences in points of view exist between DOE's conclusions and those of NRC which are based on limited and focused verification analyses. NRC and CNWRA staff have raised questions about three specific aspects of DOE analyses, namely: (a) consideration of variability of data relating compressive strength and Young's modulus of rocks; (b) use of boundary conditions in analyzing the drift-scale problem consistent with the stresses and

displacements calculated using larger repository scale analyses; and (c) use of observed/measured fracture data in the drift degradation analyses. These issues were discussed with you and by the CNWRA staff when you visited CNWRA in February 2004. The summary of your discussions is presented in your companion letter (dated March 4, 2004; Comments on Selected NRC-Sponsored Technical Assistance Programs of the Center for Nuclear Waste Regulatory Analyses).

You provided four specific recommendations based on the conclusions of the 146th and 147th ACNW meetings. The following are brief responses to the specific recommendations.

(A) Postclosure drift stability issue needs to be put in context and risk insights need to be developed: The NRC staff continue to develop drift stability risk insights. Preliminary insights have been incorporated into the staff's risk insights initiative. The ACNW was last briefed on this matter by the NRC staff at the ACNW's 148th meeting (February 27, 2004). Further analyses reflecting the actual conditions of the repository and of the revised engineered barriers design, to the extent practicable, are being conducted by the NRC and CNWRA staffs to refine our preliminary insights.

(B) Scoping calculations need to be conducted to determine the threat from drift collapse: The NRC staff's preliminary risk insights were developed using the NRC's total system performance assessment (TPA) code. The TPA scoping calculations were used to assess the effects of drift degradation on the potential failure of the drip shields and in a separate analysis the effects of drift degradation on drip shield and waste package failure. The NRC staff are developing a model of drift degradation that can be directly used in the TPA code. This model will, to the extent practicable, reflect the actual conditions of the repository and the design of the engineered barriers. As stated earlier in this letter, the NRC/CNWRA staff position on drift degradation is not based on empirical data and observations of collapsed coal mines nor was the coal mine behavior used as an analogue to the repository at the Yucca Mountain site.

(C) Impacts of drift degradation on the near-field environment should be considered: The Committee recommended that the impact and uncertainties of drift stability on engineered barrier performance be analyzed. The ACNW also recommended that the near-field environment thermal pulse, moisture flow, humidity, and perturbations from operations should be considered in the analyses. The NRC staff are considering a variety of analyses and sensitivity studies to evaluate the uncertainties and the other near field environment processes that could be affected by drift degradation. These analyses include process-level models of the thermal pulse and humidity, process-level models that address the timing and extent of drift degradation, and analyses to support revising moisture flow within the TPA code.

(D) Recent changes in ground support design should be considered in predicting drift stability: While the recent changes in DOE ground-support design mentioned by the committee contribute to increased stability of the emplacement drifts during repository operations, they are not relied on for the assessment of postclosure performance either by DOE or by NRC. The presence of a robust ground support system could postpone the initiation of the drift degradation process but cannot be assumed to be effective for extended periods after permanent closure.

Summary: The NRC staff appreciates the ACNW's continued interest and involvement in our future activities. The staff appreciates the Committee's feedback and constructive comments on the staff's approach to resolving this important issue of drift degradation and its potential impacts on the engineered barriers design and repository performance. The staff continues to focus on resolving the Repository Design, Thermal-Mechanical Effects Key Technical Issue agreements, of which the issue of drift degradation is a subset. Our approach includes discussion with DOE during technical exchanges and reviews of DOE documents, such as Analyses and Model Reports and Technical Bases Documents. We will be happy to clarify any points made in this letter during informal discussions with or formal presentation to the committee members at a future meeting.

Sincerely,

/RA Carl Paperiello Acting For

William D. Travers
Executive Director
for Operations

cc: Chairman Diaz
Commissioner McGaffigan
Commissioner Merrifield
SECY

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