



UNITED STATES  
NUCLEAR WASTE TECHNICAL REVIEW BOARD  
2300 Clarendon Boulevard, Suite 1300  
Arlington, VA 22201

July 28, 2004

Dr. Margaret S. Y. Chu, Director  
Office of Civilian Radioactive Waste Management  
U.S. Department of Energy  
1000 Independence Avenue, SW  
Washington, DC 20585

Dear Dr. Chu:

On behalf of the Nuclear Waste Technical Review Board, I thank you, your staff from the Department of Energy (DOE), and your contractor team for participating in the Board's spring meeting on May 18-19, 2004, in Washington, D.C. The Board appreciates your responsiveness to our recent letters and report on the potential for corrosion of the Alloy 22 waste packages during the thermal pulse.\* The hard work that went into preparing the meeting presentations was evident and worthwhile; the presentations provided important new information and analyses. We want to note in particular the excellent technical coordination and assistance provided by Bob Andrews, Claudia Newbury, and Mark Peters.

### **Corrosion Issues**

In its October 21, 2003, letter and in its November 25, 2003, letter and report, the Board concluded that, given the information presented by the DOE and others at the Board's January 2003 and May 2003 meetings, deliquescence-induced crevice corrosion would be likely to initiate during the higher-temperature period of the thermal pulse. That conclusion was based particularly on corrosion tests conducted in an aqueous environment rich in calcium chloride. Test results showed clearly that corrosion would take place in that environment when temperatures ranged roughly between 140°C and 160°C. The results also suggested that the expected mitigating effect of the presence of nitrate ions might not be sufficient to inhibit the corrosion process fully.

Based primarily on information presented at the Board's May 2004 meeting, it appears unlikely that dusts that accumulate on waste package surfaces during the preclosure period would contain significant amounts of calcium chloride or that significant amounts of calcium chloride would evolve on waste package surfaces during the thermal pulse. Consequently, the calcium chloride-rich environment selected for corrosion tests does not appear representative of the conditions that can be expected on waste package surfaces in a Yucca Mountain repository. If calcium chloride is not present, calcium chloride-rich brines will not form by deliquescence, and crevice corrosion due to the presence of such brines in the temperature range of roughly 140°C to 160°C will not occur. Thus, the Board concludes that deliquescence-induced localized corrosion during the higher-temperature period of the thermal pulse is unlikely.

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\*The thermal pulse is the period of approximately 1,000 years after repository closure when temperatures in repository tunnels would be above the boiling point of water.

Ideally, corrosion tests should be carried out both in environments that closely approximate the various conditions to which the waste package alloy will be exposed and in environments that reasonably bound those conditions. The extent to which the DOE has characterized accurately the likely waste package environments (i.e., temperature, relative humidity, and chemical species present) is unclear at this point. Accurate characterization of probable waste package environments and the corrosion response of the waste package alloy to those environments will continue to be a major focus of the Board's technical and scientific review.

Several corrosion issues that require additional analysis were discussed at the May 2004 Board meeting. First, the DOE raised the possibility that when temperatures in repository tunnels fall below boiling, localized corrosion could occur in concentrated sodium chloride solutions with low concentrations of inhibitors. The Board believes that further investigation of the possibilities for localized corrosion at below-boiling temperatures is warranted and that such an investigation should focus on (1) possible mechanisms that might create environments that would facilitate localized corrosion and (2) the likelihood that such environments could exist. Second, the presence of ammonium ion and the implications of its presence for corrosion or other performance aspects need to be explained. Third, the State of Nevada suggested that nitrates could be aggressive corrodents in some circumstances. The Board believes that it would be worthwhile to review existing corrosion data to determine whether they bound nitrate-containing environments that reasonably could be anticipated at Yucca Mountain.

## **Integration**

DOE contractors have been performing corrosion tests at high-temperatures in high-chloride brines for several years, presumably because it was thought that the test conditions might occur at Yucca Mountain or might reasonably bound actual conditions. However, as became clear as a result of presentations at the May 2004 meeting, geochemical considerations preclude high-temperature, high-chloride brine conditions at Yucca Mountain, rendering the corrosion tests of limited relevance. This situation underscores the need for thorough integration and close cooperation among diverse technical disciplines, particularly when "coupled" processes are involved. For example, excellent integration among geochemists and corrosion scientists/engineers was evident at the meeting and helped bring clarity to an extremely important corrosion issue. Continuing integration will be necessary for resolving other issues associated with the DOE's current repository design.

## **Hydrology and Thermohydrology Issues**

In its November 2003 report, the Board indicated that it agreed with the DOE that boiling during the thermal pulse and capillarity during and following the thermal pulse would significantly reduce the seepage of water into repository drifts but that the pervasiveness of these barriers throughout repository tunnels is not assured. At the May 2004 meeting, the DOE presented detailed descriptions of numerous field and computer investigations—many of which are at the leading edge of science—that form the basis for the DOE's high level of confidence in the effectiveness of vaporization and capillary barriers in its current repository design. In particular, the DOE maintains that there would be no seepage during the period when repository rocks are above boiling and that seepage would be limited at lower temperatures.

After reviewing the information presented at the May 2004 meeting, the Board continues to question the pervasiveness of vaporization and capillary barriers because of persistent uncertainties related to the expected repository tunnel environments. Examples of uncertainties include (1) the conceptual basis for the drift-scale thermohydrologic seepage analysis, including the axial convective transport of water vapor, air, and thermal energy in drifts; (2) the source of liquid water observed in the bulkheaded part of the cross drift; (3) the effects of drift degradation on the waste package environment; and (4) potentially unrealistic combinations of parameters used in the performance-assessment calculations of seepage.

The Board understands that significant scientific challenges are associated with analyzing the complex hydrology at Yucca Mountain, especially when the repository is subject to a large thermal perturbation. However, the Board believes that addressing uncertainties such as those noted above could create a more solid technical basis for determining whether the DOE's high confidence in the effectiveness of capillary and vaporization barriers is warranted.

### **Seismic Update**

We were very pleased to learn from the update at the May 2004 meeting that the DOE has initiated a program aimed at deriving more realistic estimates of seismic hazard at the Yucca Mountain site. In its June 27, 2003, letter to you, the Board indicated its concern about what may be physically unrealizable estimates of very low-probability (annual probabilities of exceedance of  $10^{-6}$  or less) seismic ground motion being calculated for Yucca Mountain by the DOE and its contractors. The new program appears to be a thoughtful first step. It is based on using the extent of fracturing observed in the tunnels at Yucca Mountain to limit the ground motions that could have taken place at the site during the last 10 million years. We look forward to reading the written report on these initial efforts when it becomes available and to learning more about subsequent analyses. As discussed in our June 2003 letter, deriving limits to low-probability ground motions will be challenging. We therefore urge the DOE to implement an external peer review of these efforts.

### **Transportation Planning**

Information presented at the May 2004 meeting indicates that real progress is being made in planning a transportation system for a Yucca Mountain repository. The timelines that the DOE presented at the meeting identify several important milestones that your Office of National Transportation plans to develop further into detailed project plans with cost, schedule, and technical baselines. The Board's Panel on the Waste Management System has tentatively scheduled a meeting for October 13-14, 2004, in Salt Lake City, Utah. We look forward to a more detailed review of progress in transportation planning at that time. We also would like to discuss aircraft hazard and public perceptions of transportation risk at the panel meeting.

## Concluding Comments

Once again, thank you for participating in our spring meeting and for the contributions of your staff and contractors. From the Board's perspective, the meeting met its objective: to provide a forum for the free and open exchange of views and information on the potential for corrosion during the thermal pulse. Success in achieving this objective was due in large part to the leadership you provided and to the effort that you and your staff and contractors put into conducting new studies, integrating information, and developing presentations. We also were pleased that the Nuclear Regulatory Commission, the Electric Power Research Institute, and the State of Nevada contributed their insights at the meeting. The Board looks forward to future exchanges of this kind.

Sincerely,

A handwritten signature in black ink, appearing to read "David J. Duquette". The signature is fluid and cursive, with a large initial "D" and "J".

David J. Duquette  
Chair, Executive Committee