Department of Energy
Washington, DC 20585

QA:NA

March 31, 2005

B. John Garrick, Ph.D.
Chairman
Nuclear Waste Technical Review Board
2300 Clarendon Boulevard
Arlington, VA 22201-3367

Dear Dr. Garrick:

I have appreciated the interactions we have had to date on the Yucca Mountain project. I want to be responsive to the Board's requests and continue to address your concerns. In that light, I have been "clearing the deck" of old correspondence. I realized we had still not replied to some of the issues contained in your November 30, 2004 letter. As you know, we previously responded to your transportation issues.

The enclosure addresses particular areas of your November 30, 2004, letter which I think are important for us to provide additional information.

Again, my apology for not responding sooner. I look forward to our future discussions.

Sincerely,

Theodore J. Garrish
Deputy Director
Office of Civilian Radioactive
Waste Management

Enclosure

Enclosure

Systems Integration and Stress Corrosion Cracking of the Titanium Drip Shield

The Department agrees with the Board's assessment of the importance of systematic integration and assessment of waste management activities to optimize the system as a whole and, in particular, the relationships between science and engineering. We were pleased to be able to discuss our two-tiered approach to systems integration and analysis at the Board's Winter Meeting. The upper-tier approach, known as the total system model (TSM), was initiated in early fiscal year (FY) 2004 while the lower-tier approach, known as throughput modeling, was started around the middle of FY 2004.

The TSM is a high-level model created to help estimate the logistic and cost impacts of various operational scenarios in acceptance, transportation, handling and emplacing of radioactive wastes. The TSM tracks waste shipments from the waste generating and storage sites through emplacement within the repository at Yucca Mountain, Nevada. Waste forms currently modeled in the TSM are commercial spent nuclear fuel (SNF), the Department's SNF, and defense high-level waste. The TSM also provides logistic information regarding the Civilian Radioactive Waste Management System, including information relative to the waste stream movement and the system resources (casks and their carriers) required to accomplish that movement. The lower-tier work is a suite of detailed models and studies, known generically as throughput models, and is focused on the throughput capability of each of the individual waste handling facilities at Yucca Mountain, Nevada.

The integration of the upper-tier TSM with the lower-tier throughput models helps represent the existing state of design. In the future, as these models are refined and enhanced, the TSM will support the waste management and related strategies; and the throughput models will support facility development and optimization.

Changes in engineering design or operations that have a potential to affect postclosure performance are and will be evaluated before they are formally incorporated in the baselined design. Postclosure impacts of potential changes in design and operations will be partially evaluated through preliminary sensitivity analyses by using the Total System Performance Assessment before moving forward with final design specifications. Such sensitivity analyses have been performed in the past and will be conducted using the LA design and models as appropriate. The Yucca Mountain Project (Project) activities, such as performance assessment and repository design, are carried out in accordance with a rigorous change control process to ensure integration.

At the Board's Winter Meeting, we briefly discussed Stress Corrosion Cracking (SCC) of titanium drip shields and consequences of the SCC. These topics are more fully addressed in the Project document, "Stress Corrosion Cracking of the Drip Shield, the Waste Package Outer Barrier, and the Stainless Steel Structural Material" (ANL-EBS-MD-000005, Revision 02). The model assumes that the drip shields will be subject to rockfall-induced residual stresses and will undergo SCC, independent of the environment, if the residual stresses exceed specified thresholds (50 percent of the yield stress). The report addresses the basis for the plugging of the cracks by mineral deposits and the role of capillary forces in preventing liquid from penetrating the cracks. It concludes that the likelihood of conditions conducive to SCC of the drip shield occurring in the Yucca Mountain repository is thus extremely small.

As you noted, issues related to SCC need to be addressed within the context of other corrosion tests carried out in environments that closely approximate the conditions to which Alloy 22 and titanium will be exposed and in environments that reasonably bound those conditions. In its response to the Board's letter of July 28, 2004, OCRWM discussed corrosion testing environments and likely waste package environments in the repository. The projected range of environments that could be present on the waste package and drip shield surfaces represents a heterogeneous matrix that will vary with time as the in-drift temperature and relative humidity change.

The likely concentrated brine environments and their expected frequencies and uncertainties have been calculated based on modeled repository-relevant seepage waters and the modeled behavior of soluble species in dust deposits. Although the frequency of different types of brines was not addressed at the May 2004 meeting, the results were recently documented. Because ranges of geochemical and thermal-hydrologic conditions are possible, there is a range of brine environments that could form on the waste package surface, depending on temperature, relative humidity, and the presence of intact drip shields. For the expected case, with the drip shield function intact, expected brines are of the sodium nitrate, potassium nitrate, sodium chloride, or calcium nitrate types. Dust samples collected in the tunnels at Yucca Mountain have been analyzed and grouped to summarize the types of deliquescent brines that could form. Only a few of the dust samples analyzed indicate that a calcium nitrate type brine could form. Deliquescent brines cover a pH range from approximately 6 to 12, depending on brine type and the CO_2 partial pressure. The associated chloride concentration varies from 1 to 8 molal and decreases with increasing relative humidity. Dissolved fluoride concentrations vary from approximately 10^{-6} molal to 0.3 molal, depending on the individual brines. The nitrate concentrations are greater at lower relative humidity (higher temperature) and decrease at lower temperature (increasing relative humidity). As a result, the nitrate to chloride molar ratio will vary from approximately 0.4 to 26; i.e., into the beneficial range where nitrate acts as a localized corrosion inhibitor.

Currently, work is underway to evaluate the following:

- The amount and composition of dust on waste packages as well as the volume of brine and quantities of dissolved salts, and assess the significance of any acid-gas volatilization.
- Assess the deliquescence-related properties of ammonium salts.
- Study the effects of chloride-containing silicate minerals or minerals containing hydroxide, which can be replaced by chloride.
- Document the screening argument(s) for exclusion of localized corrosion of the waste package outer barrier due to the deliquescence of dust constituents.

As mentioned earlier, past and currently ongoing corrosion tests encompass the range of these predicted environments.