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

August 3, 1999

Mr. Lake H. Barrett
Acting Director
Office of Civilian Radioactive Waste Management (OCRWM)
U.S. Department of Energy
1000 Independence Ave.
RW-2/5A-085
Washington, DC 20585

Dear Mr. Barrett:

The June 1999 meeting of the Nuclear Waste Technical Review Board (Board) focused on two topics: repository design and the Yucca Mountain Project's scientific program. In my letter to you dated July 9, 1999, the Board commented on repository design. This letter provides the Board's comments on the scientific program.

Progress is being made in many of the ongoing scientific investigations. However, given the large amount of work that remains to be done as well as the OCRWM's tight schedule for decision making and the budget uncertainties, scientists, engineers, and analysts at Yucca Mountain face a serious challenge. This letter concentrates on several issues raised as a result of the June meeting that the Board believes merit your attention.

Regarding the natural system at Yucca Mountain, we would like to highlight three areas: the need for focused investigations into the rock strata that will actually host the repository; the applicability of studies at the Busted Butte facility to the repository; and the need for an integrated approach to saturated-zone investigations.

Regarding the engineered repository system, we would like to highlight four areas: the need to vigorously pursue ongoing studies of degradation associated with stress-corrosion cracking and phase instability of proposed waste package materials; the need to determine whether presently unrecognized corrosion mechanisms exist that would be important over the very long term; the need to complete experiments on the formation of radiolysis products in the near field and to model the effects of such radiolysis products on near-field component degradation; and the need to intensify investigations into the performance of a titanium drip shield and the effect this drip shield and associated backfill would have on other elements of the engineered system.

The Natural System

Most of the detailed studies in the exploratory studies facility have, by necessity, been conducted in the middle nonlithophysal unit of the Topopah Springs formation. None has been carried out in the lower lithophysal unit, the primary host rock for the repository itself. This rock is exposed in the east-west cross drift, and initial studies show significant differences between nonlithophysal and lithophysal fracture density and the penetration depth of tunnel construction water. The thermal, hydrologic, mechanical, and geochemical properties of the lower lithophysal unit need to be investigated primarily because of their effects on the movement of water into, around, and out of the waste emplacement drifts. Closure of part of the cross drift to examine rewetting and possible seepage is very important, as are other cross-drift studies, including permeability measurements, geologic observations, and completion of analysis of chlorine-36 samples already collected. Some of these investigations are under way; others have been delayed. The Board believes that all are necessary.

Ongoing investigations at Busted Butte are beginning to show that the vitric unit of the Calico Hills formation (CHn) may significantly slow the transport of radionuclides from the repository to the water table. The CHn could emerge as an important natural barrier and play a key role in any defense-in-depth strategy. These studies need to be continued. One critical aspect of these studies not fully addressed at the meeting needs to be analyzed further: the applicability of the Busted Butte results to the rocks directly beneath the repository. At this time, the extent to which the Busted Butte results can be extrapolated to the repository and affect its predicted performance is unclear to the Board.

Before the meeting, the Board visited two sites of ongoing DOE-supported investigations conducted by Nye County scientists as part of the Nye County Early Warning Drilling Program (EWDP). We also heard a presentation on the EWDP at the meeting. The Board is impressed with the pace of these investigations and their potential for adding to the understanding of flow and transport in the saturated zone. U.S. Geological Survey and Los Alamos National Laboratory scientists also are participating in EWDP investigations. Information is being developed that challenges or adds more detail to previous conceptions of the saturated zone. The Board also noted, with interest, a conceptual model of north-south flow (presented by a State of Nevada-supported hydrologist) based on geologic structure, water temperature, and geochemistry. Clearly, much information is being gathered and needs to be incorporated in a coherent model of the saturated zone. We believe that the OCRWM should ensure the integration of these and other ongoing and proposed investigations of the saturated zone, such as the C-well type complex being considered for studies in the alluvium. Active scientific coordination and integration of saturated-zone studies would be beneficial to the program, ensuring that the maximum benefit is obtained from the data being collected and helping to prevent instances similar to the significant last-minute changes that occurred in modeling the saturated zone for the total system performance assessment in the viability assessment.

The Engineered System

The main component of the proposed waste package is made of Alloy 22. Current tests are aimed primarily at investigating this alloy's resistance to general and localized corrosion. Some studies are directed at assessing phase instability and the likelihood of stress-corrosion cracking in this material. The significance of these degradation modes at relevant repository temperatures and chemical conditions is not well known. The Board believes that these studies should be pursued vigorously, particularly those that relate to the welded and weld-affected zones of the waste package.

The primary mechanism for the corrosion resistance of both Alloy 22 and titanium is the formation of a very thin passive layer on their exposed surfaces. As long as this layer remains intact, it acts as a barrier between the metal and the oxidizing environment, greatly reducing the rate of further corrosion. Current estimates of long-term performance (i.e., performance over many thousands of years) are based on extrapolation from short-term experiments and the limited, recent history of similar metals. This extrapolation, several orders of magnitude beyond current experience, assumes that all the mechanisms for deterioration of the passive layer over thousands of years are known and can be quantified. The Board believes that there is considerable uncertainty associated with such an extrapolation. Additional research is needed to determine the likelihood of new mechanisms (beyond typical localized corrosion processes) of deterioration that could affect the very-long-term stability of the passive layer for critical waste package and other engineered barrier materials, such as Alloy 22 and titanium. This work could include, for example, examination of fundamental models of passive-regime stability and the factors that may cause deviation from passive-layer dissolution behavior assumed from short-term experiments, prediction of the behavior of the alloy surface under a thick layer of previous passive dissolution products, and a search for relevant natural and archeological analogs.

The effects of radiolysis on the degradation of waste package materials and near-field structural components in the tunnels (steel sets, rock bolts, etc.) may be much more significant using the thinner-walled containers presently being considered than the waste package assumed in the viability assessment. Research addressing the effect of radiolysis product formation on the corrosion potential of the Alloy 22 barrier was described in recent presentations to the Board. These experiments are fundamental to the development of an understanding of waste package performance. A more critical issue may be the effects of radiolysis products (nitric acid, hydrogen peroxide, etc.) on the degradation of near-field structural components. The Board supports the completion of experiments to quantify the formation of radiolysis products in the near-field environment surrounding the proposed waste package and modeling efforts for predicting the effects of such radiolysis product formation on near-field component degradation.

All five repository design alternatives presented to the Board at the June 1999 meeting rely on a titanium drip shield to protect the waste packages. Two of the designs also rely on backfill to protect the drip shield from rockfall. Although some investigations are planned or are under way for investigating the resistance of titanium to corrosion and the behavior of a scale-model stainless-steel drip shield, the Board believes that a more comprehensive program is necessary if the drip shield or backfill is to be relied on. This program should include evaluating

the effects of the drip shield and backfill on the thermal and moisture regime between the drip shield and the waste package and evaluating the corrosion behavior of titanium when it is in contact with backfill or rockfall. The vulnerability of the drip-shield connections to vibratory earthquake motion also needs to be addressed.

Finally, we note that the OCRWM is in the midst of making a decision on repository design. This choice of design could affect the importance of some scientific studies of both the natural and the engineered system. Determining the relationship among different design alternatives, the need for flexibility (e.g., going from a hot repository to a cold repository or vice versa), and the need for building long-term confidence is important. Once a design decision is made, we recommend that the scientific program be reexamined, taking these issues into account. We understand that such a process is already under way.

In conclusion, we would like to thank you, your staff, and the management and operating contractor staff for participating in the meeting. We hope that you will find these comments on the scientific program both helpful and timely.

Sincerely,

[signed by]

Jared L. Cohon
Chairman