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

July 9, 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:

During the last 10 months, the OCRWM's management and operating contractor (M&O) has been studying alternative repository designs for the proposed repository site at Yucca Mountain in Nevada. This study resulted in a recommendation by the M&O for a repository design. The Board understands that you will decide soon whether to accept, reject, or accept with modifications the M&O's recommended design.

High temperatures associated with the repository design used in the *Viability Assessment* issued in December 1998 create large and significant uncertainties about long-term repository performance. The Board believes that lower-temperature, below-boiling, designs have the potential to reduce the uncertainties as well as to simplify the analytical bases required for the Secretary's decision planned for July 2001 on whether to recommend the site for repository development.

The Board does not believe that its role is to endorse a particular repository design. However, because the design selected for the repository will affect confidence in decisions about the suitability of the Yucca Mountain site, the Board devoted considerable time to discussing repository design issues at its meeting last week in Beatty, Nevada. In this letter, the Board comments on the process for selecting the repository design and on the recommended design. Our comments are based on information from the Beatty meeting, from the Board's January 1999 meeting in Las Vegas, and from draft material furnished to the Board during the M&O's study of alternative repository designs.

Comments on the Process for Selecting the Repository Design

On April 14, 1999, the M&O recommended that the OCRWM select a design designated "Enhanced Design Alternative-II (EDA-II)." This design is characterized by (1) a repository "footprint" (area) of 1,050 acres for disposing of 70,000 metric tons of spent nuclear fuel and

high-level radioactive waste and (2) peak tunnel-wall temperatures of approximately 160ºC. EDA-II is one of six alternative designs studied by the M&O. The footprints of the designs range from 420 acres to 1,400 acres; the peak tunnel-wall temperatures range from below boiling (<96ºC) to higher than 225ºC.

The analytical process supporting the M&O's design recommendation was elaborate and resource-intensive. More than 25 reports analyzing individual design features or alternative repository designs were produced during this process. In the Board's opinion, this level of attention was appropriate because of the importance of repository design for the Secretary's site recommendation and for possible subsequent licensing. Because repository design has been considered a key issue by the Board for a long time, we are pleased that the study of alternative repository designs was undertaken. The presentations at the Board's meeting in Beatty indicate that this process has produced a much better understanding of the relative importance of the many factors involved in a repository design. The design recommended by the M&O shows much progress when compared with the design in the *Viability Assessment*.

The M&O's analysis of alternative designs was necessarily based on many assumptions. For example, the analysis assumed that the repository would be closed 50 years after the first emplacement of waste and that the ventilation system would be designed and operated so that only a portion (rather than nearly all) of the heat generated by the decay of radioactive material during the preclosure period would be removed in the ventilation exhaust. An important consequence of these assumptions was that many of the alternative designs had long periods with tunnel-wall temperatures above boiling after closure of the repository. Because of the potentially significant effects of these assumptions on repository behavior, their rationale and justification need to be carefully considered, well-grounded, and well-documented.

Selecting one design from several alternatives in the face of multiple and conflicting criteria necessarily requires value judgments. The M&O chose not to quantify or otherwise state explicitly the value judgments it used for recommending EDA-II. Because the values are not explicit, the Board — or anyone outside the process — cannot fully understand and evaluate the considerations applied in the selection. Therefore, the Board urges the DOE to be as explicit and quantitative as possible about its evaluation basis for deciding whether to accept the M&O's recommendation.

The Board realizes that issues such as operational flexibility, cost, and worker safety are important considerations in public policy: thus our emphasis on making explicit the values associated with the evaluation of these criteria. In addition, important policy choices — for example, how long the repository should remain open — currently are embedded in the evaluation process used by the M&O to reach its recommendation. These policy choices and their implications for predicted performance of alternative designs should be made explicit.

Comments on the Recommended Repository Design

In keeping with its statutory mission, the Board is most concerned about the technical defensibility of the repository system's design. The Board believes that understanding and quantifying uncertainty is central to the credibility of estimated repository performance, upon which many of the other criteria depend.

Repository design has a profound effect on the cumulative uncertainty about long-term repository performance. Thermal loading has a larger effect than any other single design attribute. In the recommended design, tunnel-wall temperatures would quickly increase to about 160ºC shortly after repository closure and would remain above boiling for more than 300 years. According to present theory, during this high-temperature period, water in the rock near the tunnel walls would vaporize and migrate to cooler areas between the emplacement tunnels, where it would condense and drain. Early results from the drift-scale heater test tend to support this theory.

Unfortunately, the understanding of water mobilization and migration processes and effects during this initial high-temperature period is still far too limited to engender a reasonable degree of confidence. Some insight into thermohydrologic response has been gained from in situ thermal tests, including initial data from the ongoing drift-scale heater test. However, important results from the drift-scale heater test will not be available for several more years, precluding their use in the context of a site-recommendation decision. In addition, in the M&O's recommended design, more than 70 percent of the repository would be located in rock having properties that are potentially significantly different from the properties of the rock in which the drift-scale heater test is being conducted. A heater test may be conducted in a section of the cross drift containing the same rock in which the majority of the repository would be located, but at what time results from this test might be available for a site-recommendation decision is uncertain.

In general, the cooler the repository, the lower the uncertainty about heat-driven water migration and the better the performance of waste package materials. An important temperature for water migration is the boiling point of water. Above this temperature, technical uncertainties tend to be significantly higher than those associated with below-boiling conditions. For the most part, cooler repository conditions also tend to lead away from regimes where waste package materials are vulnerable to severe corrosion. Considering the current uncertainties created by high repository temperatures, the Board does not believe that a strong-enough technical basis exists at this time to support adequately any above-boiling repository design. To use an above-boiling design as the basis for a site recommendation would require a significant gain between now and the time of site recommendation in the understanding of thermohydrologic processes and their effects on materials behavior.

The Board believes that many of the above-boiling designs studied by the M&O, including the M&O's recommended design, could be modified to achieve a below-boiling design simply by increasing the rate or the duration, or both, of ventilation before repository closure. A design modified to achieve below-boiling temperatures would significantly reduce existing technical uncertainties about the long-term performance of the repository, while maintaining the flexibility

to go to higher temperatures later if future data and analyses from the cross-drift heater test and the drift-scale heater test justify such action. Therefore, the Board urges the DOE to analyze carefully the implications of these and any other possible modifications that might be used to maintain below-boiling repository temperatures.

In comparison to the design in the *Viability Assessment*, additional features of the M&O's recommended repository design are titanium drip shields and backfill. The Board looks forward to learning more about the technical bases for enhanced performance predicted because of the addition of these features.

The Board would like to thank you, your staff, and M&O personnel for participating in the Board's meeting in Beatty and for the material furnished to the Board during the M&O's study of alternative repository designs. We hope that you will find these comments on repository design timely and helpful.

Sincerely,

{signed by}

Jared L. Cohon
Chairman