



**Department of Energy**  
Washington, DC 20585

June 6, 2000

JUN 22 2000

Dr. Jared Cohon  
Chairman  
Nuclear Waste Technical Review Board  
2300 Clarendon Boulevard  
Arlington, Virginia 22201-3367

Dear Dr. *Jared Cohon*:

Thank you for your letter of March 20, 2000, providing the Board's perspective on the information presented by the Department of Energy at the January 25-26, 2000, Board meeting in Las Vegas, Nevada. The Department appreciates your comment that the meeting was productive and stimulating. We, too, found the exchange to be valuable.

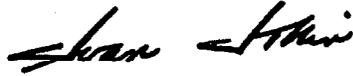
In your letter you stressed that technical uncertainties about repository performance will still be present at the time of an anticipated site recommendation decision and noted the challenge of communicating those uncertainties in a meaningful way for the purposes of decision-making. The Department recognizes that the treatment of uncertainty has always been an important factor in the decision-making process on a repository recommendation. The Department's goal is to ensure that the technical basis for any site recommendation fully describes the performance assessment results and the associated uncertainties in data and models. The technical basis will also indicate the scope of uncertainty related to the estimates of repository performance. This information will be evaluated by the Department to provide a sound scientific basis for decision-making.

The Board stated that repository operation at below-boiling temperatures would reduce uncertainties in assessing performance, in particular those associated with the complexity of thermally coupled processes. The Board has also suggested that these reduced uncertainties would increase the confidence in any site suitability determination by the Department by improving confidence in the scientific basis for the determination.

In response to the Board's recommendations, the Department is developing a flexible repository design concept that can balance technical and programmatic considerations. The Program's ongoing evaluation is focused on combinations of operational parameters that would allow a future choice from a wide range of possible thermal behaviors, including below-boiling temperatures.

The Department appreciates feedback on the meeting from the Board as we proceed toward a decision on a possible site recommendation. The Department's responses to the Board's specific issues are provided in the enclosure. If you have any questions, please contact me at (202) 586-6850.

Sincerely,

A handwritten signature in black ink, appearing to read "Ivan Itkin".

Ivan Itkin, Director  
Office of Civilian Radioactive  
Waste Management

Enclosure

**Department of Energy's Responses to the  
March 20, 2000, Letter from the  
Nuclear Waste Technical Review Board**

**Repository Safety Strategy**

*... the Board recommends that the DOE include in its representation of performance uncertainty a description of critical assumptions, an explanation of why particular parameter ranges were chosen, a discussion of possible data limitations, an explanation of the basis and justification for using expert judgments (whether or not they are elicited formally), and an assessment of confidence in the conceptual models used. In addition, the Board recommends that the uncertainties associated with the performance estimates be identified and quantified well enough so that their implications for the performance estimates can be understood. (page 2)*

The Department recognizes that it must clearly identify uncertainties, explain the sources of these uncertainties, and characterize the potential implications of these uncertainties for system performance. This work is necessary to support the technical credibility of the total system performance assessment (TSPA). The Department intends to build on its experience in preparing the TSPA report for the Viability Assessment (VA) and the supporting Technical Basis Document as it completes the TSPA document for any site recommendation (TSPA-SR) and its technical basis.

Ongoing work in developing the Analysis and Model Reports (AMRs) and Process Model Reports (PMRs) that support the TSPA-SR is documenting the basis for and treatment of uncertainty at multiple levels: from the basic data, through the conceptual models, to the abstractions that are the building blocks for the TSPA. The TSPA-SR document will provide a synopsis of those uncertainties associated with each component model. The TSPA-SR will also include detailed discussions on the treatment of uncertainty, uncertainty versus variability, and the use of alternative conceptual models. It will include presentation and analysis techniques for dealing with uncertainty. The Department's evaluation of the implications of the uncertainties on estimates of repository performance will be a major component of the TSPA-SR. The results of these evaluations will be discussed explicitly for the nominal scenario and for the disruptive scenarios.

*The Board believes that PA should not be used as the sole source of guidance about the features, events, and processes that might affect long-term repository system performance. Multiple lines of argument and evidence—combined with a clear and complete description of uncertainty—will present a much more technically defensible demonstration of repository safety than will any individual component of the safety case. The Board urges the DOE to keep this perspective in mind as the program moves forward.....We urge the DOE to ensure consideration of all elements of the safety case, including defense-in-depth, in defining principal factors. (page 2)*

The Department agrees that multiple lines of evidence and reasoning will be important to support any site recommendation. We are identifying and evaluating multiple and independent barriers to waste isolation to provide information on defense-in-depth. Insights from natural and man-made analogues are being analyzed and included in the TSPA. The underlying documentation of the TSPA calculation will include the margin by which the expected performance of the repository meets the applicable radiation protection standards.

The Department shares the Board's view that elements of the safety case beyond performance assessment should be considered in defining the principal factors. One foundation for development of a technically credible TSPA-SR is identification of the full set of features, events, and processes (FEPs) that must be considered in evaluating long-term repository performance. These FEPs are being identified through a screening process that begins with a comprehensive list of potentially relevant FEPs. The bases for identifying the initial list of FEPs for consideration and for selecting those FEPs that are actually considered in evaluating performance have been documented. Support for inclusion or exclusion of any FEP involves consideration of probability and consequences. Potentially disruptive processes and events are included to the extent that they meet the screening criteria, and natural analogue information is considered in the screening process. For each of the process models supporting TSPA-SR, an AMR is being developed to document the screening of FEPs and the bases for identifying the set of FEPs that will be considered in developing the representation of system behavior. Sensitivity studies will be used to narrow the focus to those factors (and related FEPs) that have the greatest influence on performance. Barrier importance analyses will be used to help identify factors that would provide defense-in-depth, if particular barriers did not perform as expected. The results of these various analyses will be presented in the TSPA-SR document. The Department is committed to considering all elements of the postclosure safety case in defining the principal factors to carry forward to a site recommendation decision.

*The Board recommends that the DOE reexamine its evaluation of the importance of coupled processes in its identification of principal factors. (page 2)*

The Department agrees with the Board's position. Because of the iterative nature of TSPA and development of the postclosure safety case, the Repository Safety Strategy (RSS) is periodically updated. Revision 3 of the RSS was based on the information then available. That information included the TSPA models used for the VA with modifications to reflect subsequent design enhancements, such as the use of backfill. The evaluations performed for Revision 3 resulted in the preliminary identification of seven principal factors. Workshops are currently underway to support the development of Revision 4 of the RSS. These workshops are being conducted in parallel with development of the technical basis for TSPA-SR and are considering the available TSPA results. These workshops are designed to provide a forum for consideration of the technical information being developed for a site recommendation decision and to continue development of the principal factors of the postclosure safety case. The importance of thermally coupled processes in the identification of principal factors is

being reexamined during the course of these workshops. Revision 4 of the RSS will include the results from performance analyses, sensitivity studies, and barrier importance analyses in establishing principal factors, which may be modified from those in Revision 3.

*The Board urges the DOE to pursue studies of natural analogues. The Board is concerned that there continues to be little evident progress in this area .....there seems to be no serious commitment to funding such studies. ....the Board urges the DOE to consider studies of josephinite, a naturally occurring alloy of nickel and iron that may provide insights into the long-term corrosion resistance of waste packages in a Yucca Mountain repository. (page 2)*

The Department agrees that natural analogues have the potential to increase understanding of certain processes that are principal factors in the postclosure safety case. Natural analogues can thus play an important role in supporting any recommendation and as a means of reducing uncertainty. For these reasons, funding for analogue studies has been continued in Fiscal Year 2000 despite budget constraints. These studies include continuation of work at Peña Blanca, modeling unsaturated zone flow and radionuclide transport in fractured rocks at the Idaho National Engineering and Environmental Laboratory, modeling of processes at selected active geothermal sites, a field and modeling study of Paiute Ridge intrusive bodies, and, potentially, process modeling with Krasnoyarsk (K-26) data. It is anticipated that in future years, consideration will be given to funding confirmatory studies of additional natural analogues that address Yucca Mountain processes and models.

The Department agrees that studies of metallic natural analogues may prove useful. Although josephinite is not Alloy 22, the material selected for the waste package outer barrier, josephinite and selected meteorites are metallic analogues that could provide useful information on long-term performance. Studies of these materials will continue with an emphasis on understanding the development and stability of the passive film. To date, only preliminary microstructural analysis of samples of josephinite has been performed.

*To maintain its site recommendation and licensing schedules, the program may choose to rely more heavily on performance confirmation rather than on site characterization for the information needed to determine whether the Yucca Mountain site can safely isolate wastes. If this is the case, the Board believes that the DOE should develop and communicate a carefully thought-out plan for its performance confirmation and site monitoring program as an integral part of its site recommendation. (pages 2-3)*

The Department has always viewed performance confirmation as essential to the assurance of acceptable repository performance in support of an eventual decision on whether and when to close the repository. The role of performance confirmation in the Yucca Mountain Project has not changed in light of the Project's current site recommendation and licensing schedules.

The Department expects that preliminary analysis of repository performance conducted for site recommendation, together with the safety margin and defense-in-depth provided by the multiple natural and engineered barriers in the current repository design, will provide a sufficient technical basis to judge whether the Yucca Mountain site is suitable and should be recommended for development as a repository.

As the Board, the Department, the Environmental Protection Agency, and the Nuclear Regulatory Commission (NRC) all have recognized, uncertainty about long-term repository performance cannot be totally eliminated. As one means of enhancing confidence in the understanding of repository behavior in support of the NRC decision to permit repository closure, the NRC requires that a performance confirmation program be put in place, starting during site characterization and continuing until repository closure. Such a program requires continued involvement in evaluating new information obtained during licensing, construction, operation, and monitoring of the potential repository to determine whether the essential assumptions and bases for the postclosure compliance evaluation are confirmed. The length of the post-emplacment performance confirmation period will exceed by several times the length of the site characterization period, and the actual performance of repository systems will be monitored. Therefore, the Department expects performance confirmation to lead to a significant increase in understanding and confidence before any decision to close the repository is made.

### **Repository Design**

*... the DOE committed to examining uncertainties associated with coupled thermally driven processes, to refine models that are the basis for evaluating thermal conditions, and to evaluate design options for increasing the efficiency of heat removal prior to repository closure. (page 3)*

The Department has recently initiated an effort to better quantify the uncertainties in the current thermal-hydrologic model; we will keep the Board apprised of this effort. The current design has adequate flexibility to be operated in above-boiling or below-boiling modes, and we recognize the need to further address the uncertainties associated with a choice of operating mode. Even with an above-boiling operating mode, for which boiling would be restricted to less than half of the thickness of the pillar between emplacement drifts and water could drain within the pillars, uncertainties associated with thermally driven processes would be considerably reduced compared with the design concept in the VA.

Some additional design features for increasing the efficiency of heat removal have undergone preliminary consideration; however, to date, they have not been determined to be cost-effective. The current expectation is that approximately 70 percent of generated heat will be removed through the ventilation system. Other additional design features, which have not been explored during the preliminary work done to date, may be able to remove more of the remaining heat and will be evaluated.

## **Scientific Studies**

*Regarding seepage modeling efforts, there is a need either to incorporate U.S. Geological Survey calcite deposition data and concepts into seepage models or to explain why it would be inappropriate to do so. (page 3)*

The calcite deposition data collected by the U.S. Geological Survey provides important information on seepage into lithophysal cavities. The seepage models developed by the Project will incorporate, as appropriate, these data sets, as well as the niche seepage data. The results from these models will provide additional insight about seepage into emplacement drifts over long time periods.

## **Communication**

*The DOE's initiative to develop a simplified performance-assessment capability is a commendable effort to make the "black box" of performance assessment more transparent to nonspecialists.....we urge the DOE to make this tool available to the public well in advance of the release of the site recommendation consideration report. (page 4)*

The Department intends to make a version of the simplified TSPA available to the public via the Internet and in a CD-ROM version that can be run on a personal computer. Timing of this initiative is constrained by availability of resources. We anticipate making the simplified TSPA available about the time the site recommendation consideration report is released, allowing the public to use it during the public comment and hearing process on a possible site recommendation.