Department of Energy
Washington, DC 20585

January 14, 2000

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

Dear Dr. Cohon Jerry

Thank you for your letter of November 10, 1999, providing the Board's perspective on the information presented by the Department at the September 14-15, 1999, Board meeting. We appreciate your compliments on the integration and quality of the presentations.

Your letter encourages the Department to continue important work in three areas: completing the latest revision of the repository safety strategy, testing in the cross drift related to seepage into drifts and flow in the unsaturated zone, and evaluating the new designs for the waste package and the engineered barrier system. We agree with the Board and are pursuing high priority work in these three areas. Revision 3 of our repository safety strategy was completed earlier this month. The next revision of the strategy will define the safety case for site recommendation. This revision will be traceable to the total system performance assessment and process model reports that support the site recommendation consideration report. In addition, we continue to test in the east-west cross drift and to evaluate and test new design concepts for the waste package and the engineered barrier system.

Your letter also raises two important issues related to analyzing repository performance: how to analyze and clearly present the uncertainties involved in our projections of repository performance and how to ensure the defensibility of the models we use to assess the overall performance of the repository system. We agree that both issues will be important in developing a credible basis for site recommendation and look forward to further interaction with the Board as we continue developing the appropriate methods to address them.

The Department appreciates the timely feedback from the Board as we proceed towards a decision on a site recommendation. Our responses to the Board's specific issues are provided in the enclosure. If you have any questions, please contact me at (202) 586-6842.

Sincerely,

Ivan Itkin

Ivan Itkin, Director
Office of Civilian Radioactive
Waste Management

Enclosure

Department of Energy's Responses to the November 10, 1999, Letter from the Nuclear Waste Technical Review Board

Repository Safety Strategy

- *The Board ... believes that this methodology [for barrier importance analysis] needs to be refined before valid conclusions can be drawn about defense-in-depth.*

The Department believes the preliminary barriers importance analyses conducted for the enhanced system design have provided valuable insights into the way the system performs, and the roles and contributions of the various natural and engineered barriers. These analyses, which involved the neutralization of barriers and processes, were based on the models developed for the Viability Assessment, with appropriate adjustments to reflect revisions to the design. The results were considered in the process of identifying the principal factors for the postclosure safety case described in Revision 3 of the Repository Safety Strategy. The Department is aware of the limitations in these neutralization analyses and intends to refine the method before using it with the updated total system performance assessment models being developed to support site recommendation. The refined method for neutralization analyses, and possibly other methods, will be employed to examine system performance and draw conclusions about the contributions of the various barriers and the degree of defense-in-depth provided by the updated design. The refined evaluations of the performance of key barriers will be documented in the next revision of the Repository Safety Strategy and will be fully traceable to the total system performance assessment documentation for site recommendation.

- *Unless the DOE can support its choice of principal factors and its use of bounding analyses, making the repository safety strategy technically persuasive will be difficult.*

As the Department noted in the September Board meeting, the selection of principal factors is a work in progress. The proposed principal factors discussed in Revision 3 of the Repository Safety Strategy were selected using professional judgment of the principal investigators, existing sensitivity studies, and insights from preliminary barrier importance analyses. This revision of the Repository Safety Strategy provides the rationale for the selection of the seven principal factors for the postclosure safety case. The next revision of the Safety Strategy will be based on the documented results from the total system performance assessment that is being conducted to support site recommendation, including information from the supporting Analysis and Model Reports and Process Model Reports. These results will provide the technical basis to confirm or revise the set of principal factors for the postclosure safety case for site recommendation, and for the work to be done to enhance the safety case for licensing.

The Department agrees that if bounding analyses are used in the evaluation of system performance, they must be technically sound and defensible. The Department plans to develop models and conduct analyses that are as realistic as possible, given the data that are available. In some instances, use of conservative or bounding analyses may be the only credible approach. In other instances, sensitivity studies conducted for site recommendation may indicate that performance is relatively insensitive to certain models or processes. In such cases, it may be appropriate to use a conservative or bounding approach in licensing to facilitate a focus on those aspects of system performance that are the most important to the findings that need to be made. Revision 3 of the Repository Safety Strategy identifies possible candidates for such simplification. Sensitivity studies conducted for site recommendation will be used to confirm or revise this list of candidates.

Model Validation

- *Significant issues associated with model validation may not be examined adequately by the time the final site recommendation report is scheduled to be sent to the President.*

The Department's goal is to establish adequate confidence in the relevant models by the time the site recommendation report is completed to support a decision by the Secretary. Validation is a process used to provide confidence that a conceptual model, as represented in a corresponding mathematical model, software, or analysis, adequately represents the phenomenon, process, or system being modeled. As the Department noted in the September meeting, the goal of model validation as defined by our quality assurance program is to establish the adequacy of the scientific basis for a model and to demonstrate that this basis is sufficiently representative for its intended purpose. The level of confidence required for a specific model is tied to the importance of that model to the safety case for the decision at hand. One goal of the Repository Safety Strategy has been to identify the elements of the repository system that are most important to system performance. This allows ongoing investigations to be focused on these elements and the validation of the models used to represent the performance of these elements.

The Department is validating models by comparison of modeling results to independent lines of evidence from laboratory observations, field observations, analog studies, and alternative models. Peer review panels may be convened to review the model, the underlying assumptions, and the results. Validation is an ongoing process that will continue after site recommendation, if the site is found suitable. The Department plans for additional monitoring and data collection to test our models and enhance confidence in their validity, including testing of phenomena that are calibrated with short-term data.

Treatment of Uncertainty

- *The DOE has an important obligation to present its technical analyses in a way that gives policy-makers ... as well as interested members of the general public a clear understanding of the uncertainties involved in projecting the performance of a repository.*

The Department agrees that it is important to present technical analyses in a way that provides the policy-makers and members of the interested public a clear understanding of the uncertainties in projecting the long-term performance of the potential repository at Yucca Mountain. The Department will discuss its approach to addressing uncertainty in the total system performance assessment for site recommendation during the Full Board Meeting in January 2000. The Department is looking forward to receiving additional feedback from the Board following this meeting regarding its views on how uncertainty can be evaluated and presented.

Modeling Results and Technical Investigations

- *[The tentative] conclusion [regarding the existence of a seepage threshold] is an extremely important one but ... it is highly dependent on assumptions about shape of the drift and ... structural integrity.*

The Department agrees that the concept of a seepage threshold presented in the discussion of the seepage flux model at the September Board meeting is an important one. Recent analysis reported in the Seepage Calibration Analysis and Modeling Report (AMR) has lowered the calculated seepage threshold for the Middle Non-lithophysal unit from 1000 to 200 mm/yr. The Department also agrees that it is important to evaluate the effects of the shape of the drift on seepage, and this work has started and is reported in another AMR entitled, "Seepage Model for PA". Furthermore, the Department will soon start testing the seepage characteristics of the main repository unit, the Lower Lithophysal unit. We are looking forward to receiving feedback from the Board regarding its views on the appropriateness of the model of seepage flux and the concept of a seepage threshold for inclusion in our performance assessment for site recommendation.

- *Concern still exists about the effects on corrosion of radiolytic species, including species formed in the vapor phase.*

With adoption of the new thinner-walled waste package design, the radiation levels at the surface of the waste packages are expected to be higher than for the thicker-walled viability assessment design. To assess potential radiolysis effects, the Department has conducted calculations of radiation levels at various locations within the drift for the new design. These calculations show that the waste package surface radiation dose levels for the bounding case (21-PWR, 75,000 MWD/MTU, 5-year cooled fuel) are less than 3000 rad/hr at emplacement

and decrease to about 260 rad/hr after 50 years. The radiation levels will continue to decrease if the repository is kept open for a longer period. Since the radiation levels required to cause significant enhancement of corrosion for the nickel and titanium alloys that are planned for used in the waste package and drip shield range from 10,000 to 100,000 rad/hr, the potential impact of radiolysis on the corrosion behavior of the new design is expected to be negligible.

Current plans call for forced ventilation of emplacement drifts for at least 50 years after emplacement. With ventilation during preclosure, the relative humidity will be about 20% or lower, which is well below that required for surface films to be generated. During this time, there is little likelihood of forming a water film on the near-field components within the emplacement drifts (e.g., ground support, waste package support structures, and invert materials). Further, any species formed in the vapor phase are not likely to cause a concern if the products cannot condense on the metal surface. The calculated radiation levels on the near-field components are expected to be about 2000 rad/hr or less at emplacement and decrease to less than 200 rad/hr after 50 years. Doses at the rock bolts would be substantially lower. This suggests that the potential for radiolysis enhanced corrosion of near-field structural components or rock bolts is also negligible.

- *The DOE has not established the technical foundation for the performance claims it is making for the drip shield.*

The Department agrees with the Board's view, and has enhanced its ongoing investigations of titanium drip shield performance and the effects of the drip shield on other elements of the engineered system to strengthen the technical basis for the performance of the drip shield. The Department is conducting a broad-based, comprehensive testing program that considers known corrosion mechanisms, as well as examining engineered and natural analogs. The tests focus on the corrosion mechanisms considered to be relevant to expected repository conditions. Accordingly, the work includes testing under service conditions and aggressive conditions in order to develop models for prediction of the long-term performance of the drip shield. Specifics of the testing program were recently provided to the Board (Barrett 1999).

Reference:

Barrett, L.H. 1999. Letter from L.H. Barrett (DOE/HQ) to J.L. Cohon, November 23, 1999.