



UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD
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Dr. Margaret S. Y. Chu
Director
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dear Dr. Chu:

On behalf of the U.S. Nuclear Waste Technical Review Board, I want to thank you for participating in the Board's meeting on January 28, 2003, in Las Vegas, Nevada. We found your program overview and the presentations by individuals from the Department of Energy (DOE) and its contractors very clear and helpful to the Board in carrying out its responsibility to review the scientific and technical validity of DOE activities. The Board's observations and several recommendations drawn from the information presented at the meeting are summarized below.

Natural Barriers

Encouraging the DOE to develop a better fundamental understanding of the potential behavior of the natural barriers in a Yucca Mountain repository has long been a Board priority. Two presentations at the meeting dealt with issues that have relevance for such understanding.

Chlorine-36 – The Board previously has recommended that the DOE resolve the contradictory analyses related to the possible presence of bomb-pulse chlorine-36 at the repository horizon. The Board realizes that the DOE's conceptual and numerical models for flow and transport in the unsaturated zone attempt to reduce the relevance of the contradictions by assuming the presence of fast flow paths in the unsaturated zone. However, the Board believes that developing a basic understanding of key processes inside Yucca Mountain that may affect repository performance is essential. This understanding should include whether or not fast flow paths are present in the unsaturated zone and the extent of rapid water movement through the fast paths if they do exist. In addition, discrepancies in results between two DOE-supported groups measuring the same phenomenon affect the credibility of the program. The Board continues to believe that the DOE should persist in its efforts to reach scientific consensus on the results of the chlorine-36 analyses and the implications of those results for fluid flow in Yucca Mountain.

Paleosols – Field investigations and numerical modeling of heterogeneous alluvial sedimentary deposits show that even relatively thin low-permeability deposits can significantly alter directions and rates of water flow and chemical transport in the saturated zone. Ancient soils known as "paleosols" can form these thin low-permeability deposits within alluvial

sedimentary sequences and are known to occur in the Yucca Mountain region. Also, depending on their mineralogical properties, paleosols can potentially retard the chemical-transport rates of some radionuclides. Taken together, these characteristics suggest that paleosols merit exploratory investigation by project hydrogeologists.

Engineered Barriers

As noted in previous Board reports and letters, uncertainties related to the performance of the engineered barriers are extremely important, particularly given the prominence of the engineered barriers in DOE estimates of repository performance and DOE's decision to use a high-temperature repository design in its license application. Several presentations at the meeting dealt with factors that could affect the potential performance, development, or procurement of the engineered barriers in a Yucca Mountain repository.

Corrosive environments – Contractors for the State of Nevada presented experimental results showing that highly corrosive brines and condensates can be produced at laboratory scale by distillate boiling of concentrated synthetic porewaters at atmospheric pressure. However, the presentations did not include a specific sequence of events that would cause such corrosive solutions to develop in a repository at Yucca Mountain. The presentations also did not include estimates of the likelihood that such solutions would occur in a repository or of the extent of such solutions if they were to occur. Dr. Joseph Farmer gave a very informative presentation on the Project's view that the evolution of such highly corrosive environments in a repository at Yucca Mountain would be unlikely. Except in the case of acid-gas generation, however, his presentation did not include the Project's technical basis for this view (i.e., that the generation of certain highly corrosive solutions would be either implausible or so unlikely or minor in extent as to be insignificant).

Clearly, corrosive solutions are *possible*; the necessary porewater, decay heat from the waste packages, and in-drift conditions (i.e., high temperatures, pressure, humidity) would be present in a repository at Yucca Mountain. However, the Board does not know, at this point, whether a case can be made that corrosive solutions would be so likely and widespread that they would be a concern or whether a case can be made that they would be so unlikely and sparse that they would be insignificant. Presentations convey data, views, and progress, but complex hypotheses and models require carefully prepared and reviewed technical reports for their explanation and defense. Thus, we urge the Project to ensure that the analysis and model report (AMR) that deals with the evolution of chemical environments on waste package surfaces contains a defensible technical basis, including the full logic, explanations, and assumptions underlying the Project's view that widespread corrosive solutions are unlikely.

We asked at the meeting whether a repository with lower peak temperatures of waste package surfaces would reduce the uncertainty, likelihood, or severity of corrosive solutions. However, the question was not answered directly. The Board believes that the Project should answer this question, and, if the answer is "Yes," a second question, "How much?" also should be answered. The technical basis for both answers should be documented carefully and completely in an AMR.

Materials studies – The Board was encouraged by the information presented on studies of corrosion in the presence of deliquescence, seepage, and CaCl₂ brines, but we note that many more studies, especially at elevated temperatures, will be needed to adequately explore potential corrosion mechanisms and corrosion rates in a high-temperature repository. The Board concurs with the observation of the Waste Package Materials Performance Peer Review Panel that the Project staff needs a senior-level, visionary leader with a strong background in materials science and engineering and with very good management credentials. Such a person could develop a systematic approach for identifying needed materials studies, ensure continuity of the effort, and enhance communication with the technical community.

Prototype manufacturing – The Board is pleased that the DOE plans to procure waste package prototypes and develop welding processes. Programs in other countries that have undertaken prototyping activities have learned a great deal. In fact, some programs have encountered surprises that have taken considerable time to resolve. Manufacturing waste packages to the specifications required for a repository may require a significant development effort and corresponding lead-time before repository operations can begin. Information presented at the Board meeting did not contain detailed justification for the number of prototypes planned, but the Board concurs with the timing of the initial development effort. The Board strongly urges the DOE to begin prototype development as soon as possible.

As experience is gained, useful modifications of the waste package design may be identified. For example, the DOE may find that dual Alloy-22 lids may not be justified in light of the manufacturing complexity associated with a dual-lid design. The current plan not to stress-relieve or otherwise mitigate tensile stresses of the inner Alloy-22 closure weld also raises questions about the value of the dual-lid concept. Finally, because the trunnion-collar sleeves appear complex and their attachments to the waste package appear prone to crevice corrosion, there may be a need to reconsider these parts of the design during prototype manufacturing.

Repository System and Integration

The Board also has urged the DOE to gain a better understanding of the potential behavior of the entire repository system through continued scientific studies and through analysis of the contribution of different barriers to repository performance. Presentations at the meetings touched on these issues.

Barrier performance – The Board is pleased that the DOE continues exploring ways to determine and display the contributions of individual barriers to performance of the overall repository system. The Board believes that such analyses can provide important insights into the respective roles of the different barriers. Furthermore, there appear to be opportunities for improving both the analytical approach for analyzing the performance of individual barriers and the clarity of the presentation of study results. The Board urges the DOE to continue this effort.

On-going scientific studies – Results from scientific studies, such as experiments in the cross drift and the cool-down phase of the drift-scale heater test, may be very valuable in increasing understanding of the potential behavior of a repository system at Yucca Mountain. However, these studies will require adequate funding and the attention of management to realize

their true potential. As the Yucca Mountain project focuses on licensing activities, the temptation may be to divert resources from scientific studies to the licensing effort. The Board encourages the DOE to institute mechanisms that will ensure adequate funding and management commitments to on-going scientific studies.

Waste Management System

With the approval of the site recommendation, the DOE's plans for operating the waste management system, including waste acceptance, transportation, and operations at a Yucca Mountain repository, have become extremely important. Since funding constraints in this area have caused plans to be deferred for several years, the Board is pleased to see that the DOE will resume work on the waste management system this year. The Board views this as a very important area and will hold additional meetings to review DOE plans in the coming months.

The Board recommends that the transportation planning and development effort adopt a "systems" approach, addressing both strategic and operational considerations. The Board views the early involvement of external stakeholders as critical to developing a comprehensive plan for the waste management system and to building public confidence in those plans. Because proactive engagement of external stakeholders is a time-consuming process, the Board encourages the DOE to initiate this activity as soon as possible.

Once again, the Board thanks you, the DOE staff, and the DOE contractors for supporting the Board's January meeting. We look forward to continuing our ongoing technical and scientific review and to commenting on DOE activities in the future.

Sincerely,

[Signed By]

Michael L. Corradini
Chairman