



Department of Energy

Washington, DC 20585

September 6, 2002

SEP 16 2002

Dr. Michael L. Corradini, Chairman
Nuclear Waste Technical Review Board
2300 Clarendon Boulevard
Arlington, VA 22201-3367

Dear Dr. Corradini:

On behalf of the Department, I would like to extend my congratulations on your appointment as Chairman of the Nuclear Waste Technical Review Board. I look forward to a long and positive association with you and the Board. I would also like to take this opportunity to extend my thanks to the outgoing Board Chairman, Dr. Jared L. Cohon, and to Dr. Donald D. Runnells, Dr. Alberto A. Sagüés, and Dr. Jeffery Wong for their years of dedicated service as members of the Board.

In his June 20, 2002, letter, Dr. Cohon provided the Board's perspective on information presented by the Department at the Board's May 2002 Board Meeting. Based on the presentations at that meeting and previous oversight activities, the Board provided comments in two general areas for the Department to consider in planning future studies at the Yucca Mountain site:

- Increasing confidence in the understanding of waste package corrosion and long term repository performance
- The potential value of a new organizational structure that will increase fundamental understanding of the repository system

The DOE agrees with the Board about the importance of both of these topics. Our current plans include work that will address the comments that the Board provided in its June letter. Those comments are discussed in the attachment to this letter.

The Department has benefited from the constructive views of the Board. We appreciate the Board's review of our activities as we develop a license application for a repository at Yucca Mountain, and look forward to continuing our dialogue with the Board on these and other important issues.

Sincerely,

Dr. Margaret S.Y. Chu, Director
Office of Civilian Radioactive
Waste Management

Enclosure



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***DOE discussion of NWTRB Comments on
Increasing Confidence in the Technical Basis for Estimates of Repository
Performance, June 20, 2002***

Waste Package Corrosion

The Board commends the DOE for convening the Waste Package Materials Performance Peer Review Panel, whose excellent final report is both comprehensive and timely. The report contains many recommendations for further research and development that should increase confidence in the technical basis for predictions of the long-term performance of the waste package. ...The Board continues to believe that the technical basis for extrapolating corrosion behavior over thousands of years needs to be more firmly established. The DOE should continue to search diligently for natural and archaeological analogues and should perform experimental and analytical studies on the analogues that appear to have been protected for long periods by passive layers.

The DOE agrees that this Peer Review produced an excellent and comprehensive review of the current basis for predicting the long-term performance of waste package and drip shield materials and the adequacy of plans for future study. The DOE is in the process of evaluating the Panel recommendations as we plan testing and analysis for the next phase of the Yucca Mountain Project. We will continue to look for natural and archaeological analogs that appear to have been protected by passive layers for long periods. If found, they would be excellent candidates for experimental work to establish independent lines of evidence for the behavior of passive layers.

Repository Design

...the Board is encouraged that the DOE is committed to preserving the option of a low-temperature repository. However, the technical basis for the DOE's selection of a high-temperature repository design for a potential license application remains unclear to the Board in view of the uncertainties associated with a high-temperature design and the lack of data on high-temperature corrosion.

In 1998, the DOE did evaluate a high temperature design with a drift spacing of 28 meters as the base case for the Viability Assessment (VA). The performance assessment analyses for that design projected postclosure thermal conditions in which the boiling zones of adjacent drifts coalesced. For the Site Recommendation (SR), we selected a single design with a drift spacing of 81 meters. Analyses of that design showed postclosure thermal conditions that were lower than those projected for the VA design. Moreover, the SR design accommodates a range of preclosure operating modes that can be used to modify the early postclosure conditions. For the base-case operating mode of the SR design, drift wall temperatures are projected to be above boiling in the early phases of the postclosure scenario and a dry-out zone extends several meters into the rock around the drifts, but a portion of the pillars between drifts remains below the boiling point of water. This concept is intended to promote drainage of thermally mobilized

water through the central portion of the pillars and thus to ensure hydrologic independence of the individual drifts. The lower temperature postclosure conditions in the base-case SR design, compared to the Viability Assessment design, have tended to increase confidence and reduce uncertainties in the analysis and modeling of thermal effects on the natural system. This results from reducing the volume of rock and water that is perturbed by the thermal pulse.

DOE also analyzed the SR design for an alternative case where preclosure operating modes were used to modify the postclosure thermal conditions, keeping the average surface temperature of the waste package below 85°C. In comparing the postclosure results of the two cases, the uncertainties in the base-case SR design may be greater than the cooler alternative case during the first few thousand years. However, those uncertainties are primarily related to the subsystem performance calculations for the near-field environment, and there is no discernable difference in uncertainty as measured in the current total system performance assessment models. Results of the total system performance assessment analyses for both cases indicate that calculated dose rates using the SR design are well below the limits set by the Nuclear Regulatory Commission and the Environmental Protection Agency. The DOE believes that the base-case operating mode for the SR design, that results in postclosure thermal conditions at the higher end of the expected range, provides a better balance of postclosure thermal conditions and preclosure advantages for construction and operations, flexibility, and cost. While this operating mode has been selected for evaluating repository performance in the Total System Performance Assessment for the License Application (TSPA-LA), DOE will continue to evaluate the lower temperature option as an alternative operating mode. The lower temperature option will be carried forward with the objective of minimizing impacts on the overall schedule if this option is selected. For the purpose of the License Application, it is necessary to analyze the proposed operating mode in order to demonstrate whether or not the repository system meets the Nuclear Regulatory Commission's applicable regulatory criteria. If a different operating mode is eventually selected, then that mode would require approval by the NRC.

The DOE has decided to provide a repository design that will allow loading the repository to accommodate a range of operating modes and to defer the final decision on postclosure thermal conditions until more data are available to support this decision. These data may be collected as part of our baseline program, or as part of the new Science and Technology Program. We have also laid out a time frame to monitor ongoing data collection and to evaluate if new data support a decision on the postclosure thermal conditions, as presented to the Board in May 2002. In the Waste Package Material Performance Peer Review¹, the Panel concludes that

“...the benefits of moving from the high temperature operating mode, as currently defined, to a low temperature operating mode are not clearly greater and might be

¹ Beavers, J.A.; Devine, T.M., Jr.; Frankel, G.S.; Jones, R.H.; Kelly, R.G.; Latanision, R.M.; and Payer, J.H. 2002. *Final Report, Waste Package Materials Performance Peer Review Panel, February 28, 2002*. [Las Vegas, Nevada]: Waste Package Materials Performance Peer Review Panel.

offset by the effects of radiolysis, in addition to long-term ventilation and increased area for the repository.”

The DOE concurs with the Panel’s conclusion with respect to the postclosure thermal conditions. As noted above, testing and analyses are ongoing to improve the technical bases for projecting both higher and lower postclosure thermal conditions. As additional data and analyses are completed, the DOE will re-evaluate the postclosure thermal strategy.

...DOE’s current high-temperature repository design differs from the one assumed in the documentation for the site recommendation in key areas, such as waste package spacing.

The current baseline design is the SR design. This design has fixed engineering parameters, such as drift spacing and drift diameter, and variable operating parameters, such as areal mass loading, average waste package spacing and ventilation system operation. Various combinations of operating parameters were used to evaluate different postclosure thermal conditions that can be achieved with the SR design. These scenarios included average waste package spacing that varied from 0.1 meters to 6 meters. While all permutations of operating parameters were not evaluated, DOE is confident that the combinations that were evaluated adequately bound the postclosure conditions. Current design considerations are consistent with the SR approach and within the range of operating parameters considered for the SR design. As discussed previously, the DOE will evaluate repository performance in the TSPA-LA based on an operating mode that results in above boiling conditions in the early phases of the postclosure period.

Repository Safety Case

...the Board strongly supports the DOE’s efforts to develop a repository safety case now for supporting a potential license application and for improving the DOE’s communication with decision-makers and the public.

The DOE believes that the case for safety of a repository will be embodied in the licensing bases being developed for the LA. The licensing bases for both preclosure and postclosure repository performance will include the results of quantitative assessments of the performance of the repository system, as well as other lines of evidence that provide confidence that the results are reasonable and robust. For the postclosure evaluation, these additional lines of evidence will include the description of multiple natural and engineered features and systems that will act as barriers to the migration of radionuclides and the use of natural and man-made analogs to assess the reliability of the systems performance models. The licensing bases will also include a commitment to a performance confirmation (PC) program. For preclosure, the evaluation will include a quantitative safety analysis of all repository structures, systems, and components. Additional confidence building measures defined for the preclosure licensing bases include the use of margin and defense-in-depth in design, consequence analysis of

beyond-design basis events, reliance on commercial nuclear reactor precedent and experience, and compliance with all license specifications and surveillances.

Performance Confirmation

...The Board believes that performance confirmation should focus on evaluating the validity of estimates of long-term repository performance and challenging their underlying assumptions.

The Test and Evaluation Program and the Performance Confirmation (PC) Program are being revised in response to the issuance of 10 CFR Part 63² and the draft Yucca Mountain Review Plan³. Analysis of the regulation identified seven types of required testing, one of which is performance confirmation. DOE has developed an approach to manage these seven types of testing in an integrated manner, and has identified interfaces between them as well as the overlap of some tests among multiple regulatory requirements. 10 CFR 63.2 defines Performance Confirmation as “the program of tests, experiments, and analyses that is conducted to evaluate the adequacy of the information used to demonstrate compliance with the performance objectives of Subpart E of this part” (10 CFR Part 63).

10 CFR Part 63 Subpart F defines the requirements for a PC program. In developing the PC program, DOE will define the parameters and the extent of testing and monitoring for each parameter using a risk-informed performance-based approach. A decision analysis process is underway to develop and apply parameter selection criteria. The risk-informed approach to PC program definition is strongly related to the licensing bases, which includes numerical analyses and qualitative arguments of the complementary performance of nine individual natural and engineered barriers. Thus, the revision of the PC program and the development of the licensing bases are being conducted in tandem.

Adaptive Staging

The Board encourages the DOE to develop a better understanding of adaptive staging and to analyze the implications of this approach for its present organization and for its interaction with the public.

The concept as described in the National Research Council panel's interim report⁴ was generic - intended to be broadly applicable to any repository program at any stage of development. In the United States (U.S.), a comprehensive law specifying national policy, court-affirmed contractual obligations for the Federal government to accept and dispose of spent fuel, a fully-developed regulatory framework, and formal designation of

² 66 FR 55732. Disposal of High-Level Radioactive Wastes in a Proposed Geologic Repository at Yucca Mountain, NV. Final Rule 10 CFR Part 63.

³ Center for Nuclear Waste Regulatory Analyses. 2002. *Yucca Mountain Review Plan, Draft Report for Comment*. NUREG-1804, Rev. 2. Washington, D.C.: U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards.

⁴ National Research Council. 2002. *Principles and Operational Strategies for Staged Repository Systems*: Progress report. Washington, D.C.: National Academy Press.

a site at Yucca Mountain are already in place. DOE believes that the elements of adaptive staging already exist in the U.S. waste management system but are constrained by the realities of where the DOE is in the repository development process. The program has changed in many ways over the years in response to new information from various affected and interested parties, including the NWTRB. DOE expects that there will be continued opportunities to make improvements to design and operations as information is obtained from the Science and Technology Program that was described at the Board's May 2002 meeting. DOE also believes that there may be better ways to stage repository development within the present regulatory and legislative constraints. DOE is looking forward to the findings and recommendations of the panel concerning the application of the concept of adaptive staging to the specific case of the Yucca Mountain project and will give careful consideration to any findings and recommendations.

The presentation on flexible repository design and thermal operating conditions came closest of all the presentations at the meeting to illustrating how adaptive staging might work during performance confirmation. In that presentation, discrete decision points were identified, additional data that need to be collected and integrated were specified, milestones for reevaluating and reassessing decisions were established, and choices that might foreclose future options were clearly highlighted. Just as technical flexibility will be a prerequisite for adaptive staging, it is essential that the DOE be willing to make midcourse technical or programmatic corrections during performance confirmation if they are required. In summary, using adaptive staging will require that the DOE address with specificity the following questions: What information can be gathered over what time frame? How will that information be used to determine whether previous decisions and assumptions about repository performance remain valid? What midcourse corrections or remedial actions, if any, are warranted?

The DOE agrees that the approach being developed for dealing with postclosure thermal conditions through use of a design with flexible preclosure operating modes may be a good example of the application of adaptive staging during the repository development and operations phase. DOE also expects to extend that approach to other aspects of repository development that could be affected by new information that could become available during repository construction and operation.

The DOE will make any changes to the program necessary to assure worker and public health and safety, in response to new information gained during repository development through the NRC licensing process, if necessary. The NRC requires continued evaluation of new information obtained during licensing, construction, operation, and monitoring of the repository to determine whether the essential assumptions and bases for the postclosure compliance evaluation are within the limits assumed in the licensing review and are functioning as intended and anticipated. DOE must report significant deviations from expected conditions and recommend any action (including design changes or even retrieval of emplaced waste) that might be required in accordance with 10 CFR 63.44. These requirements are an example of how the existing U.S. system for managing high-level waste already contains significant elements of adaptive staging as described by the National Research Council.

DOE is establishing a separate group to deal with research and development activities that are not directly linked to the licensing and regulatory process but that could lead to improvements that could be incorporated into the system at some stage during repository development and operation. Such improvements will include developing a better understanding of the coupled (thermal-chemical-hydrologic-mechanical) processes that will affect repository performance. If any of these activities support a conclusion that a change to the reference design or operating plan would be desirable, we would certainly consider proposing such a change and seeking a license amendment if that were required. As you know, we are also considering adoption of a modular construction approach that would further enhance flexibility to incorporate design or operational changes during the course of repository development.

New Organizational Structure

As noted in the Board's January 24, 2002, letter report to Congress and the Secretary of Energy, improving understanding and filling in existing data gaps are important for increasing confidence in estimates of repository performance and for better defining necessary activities associated with performance confirmation. At the May meeting, the DOE informed the Board that it had established a task force to develop options for increasing fundamental understanding of the proposed repository system and for increasing confidence in projections of repository performance. Of course, the Board expects that work directed toward a potential license application would increase confidence as well. New information and analyses may have important implications for the development of a safety case as well as for repository design.

Any work undertaken by this task force not only should supplement but also should be integrated with the work already planned for a potential license application.

The DOE fully agrees with the Board about the value of improving understanding and addressing data gaps related to repository performance. As a result of the work of the DOE Science and Technology Task Force described at the May meeting, we are establishing a Science and Technology program aimed at increasing confidence in repository performance and improving safety, operations, schedule, and cost over the many decades of the repository's operating life. Such a program has been recommended by the National Research Council⁵ and DOE's Strategic Laboratory Council⁶. This effort will engage the expertise of the National Laboratories, universities, and the international scientific community. It will seek to increase confidence in the repository by advancing the basic scientific and technical understanding of the waste isolation processes at Yucca Mountain and exploring technological improvements that could improve repository

⁵ National Research Council. 2001. A Strategic Vision for Department of Energy Environmental Quality Research and Development. Washington, D.C., p.50.

⁶ Department of Energy. September 2000. Adequacy Analysis of the Environmental Quality Research and Development Portfolio. Washington, D.C., p. 27.

performance and increase system efficiency. It will also continue to refine and optimize the repository system design and operating plan, based on laboratory and university research, value engineering, and the experience from the initial period of repository operation. Improvements can be incorporated, consistent with the concept of staged development. As noted earlier, activities in this program will focus on areas that are important to our mission, but may not be immediately incorporated into the licensing and regulatory process. DOE will also continue its Core Science Program and Performance Confirmation activities that are required for the near-term licensing effort. As suggested by the Board, the work in the new Science and Technology program will be coordinated and integrated with these other activities directed towards the licensing process.