



Department of Energy

Washington, DC 20585

March 31, 1992

Dr. Don U. Deere
Chairman, Nuclear Waste Technical
Review Board
1100 Wilson Boulevard
Arlington, Virginia 22209

Dear Dr. Deere:

This letter transmits the Department of Energy's (DOE) responses to the Nuclear Waste Technical Review Board's recommendations made in its Fourth Report to the U.S. Congress and the U.S. Secretary of Energy that was issued on December 10, 1991. Our responses to the Board's 10 recommendations may be found in the enclosure.

I am pleased to note that the program has made significant progress since your previous report that was dated May 1991. As noted during our meetings, we are conducting surface-disturbing activities at the Yucca Mountain site for the first time since 1986. This work not only gathers data that is essential in resolving the site suitability issues, but it also permits us to demonstrate program progress. This progress is essential in maintaining the support of program stakeholders and Congress. As I explained during our recent meeting with the Board, I have chosen to advance the Exploratory Studies Facility design effort as much as practical, while still maintaining the surface-based testing program needed to sustain program progress. As evidenced by our responses to the Board's report, I believe that our strategies, activities, and plans are largely consistent with the Board's recommendations.

In the coming months, we hope to accomplish several programmatic milestones. We intend to issue the baseline site suitability evaluation report and the preliminary repository system performance assessment report for public comment. We welcome the Board's comments on these important technical documents. These efforts, along with the expansion of the site characterization activities, and the siting activities for the MRS facility provide the strategic focus for the program in the coming year.

With the synthesis of site characterization data, we also hope to resolve several of the basic suitability questions concerning the Yucca Mountain site. I hope to get the Board's input on approaches for dealing with the residual uncertainty associated with data collection and a consensus on how to balance data, peer

review, and expert judgment in order to produce a defensible performance assessment. The resolution of these issues is essential to the basic determination of site suitability.

We appreciate the Board's reviews, insightful comments, and recommendations on the content and performance of our program. The Board's independent oversight is essential in affirming the soundness and quality of the Civilian Radioactive Waste Management program. We look forward to working with you and the Board in the future.

Sincerely,

John W. Bartlett, Director

Office of Civilian Radioactive
Waste Management

Enclosure

**DOE Response to the Recommendations of the
Nuclear Waste Technical Review Board in Its
Fourth Report to the U.S. Congress and the U.S. Secretary of Energy
December 1991**

INTRODUCTION

The Nuclear Waste Policy Amendments Act of 1987 established the Nuclear Waste Technical Review Board to evaluate the technical and scientific validity of activities undertaken by the Department of Energy (DOE) in the Office of Civilian Radioactive Waste Management (OCRWM).

The Board is required to report, not less than two times per year, to the Congress and the Secretary of Energy, its findings, conclusions, and recommendations. The Board has issued four reports to date. The fourth report, issued on December 10, 1991, includes 10 recommendations in 5 broad areas: (1) structural geology and geoengineering; (2) hydrogeology and geochemistry; (3) the engineered barrier system; (4) the environment and public health; and (5) risk and performance analysis.

These recommendations and DOE's responses are presented in this report. Each recommendation is quoted verbatim from the Board's report of December 10, 1991, and is followed by the response.

STRUCTURAL GEOLOGY AND GEOENGINEERING

These recommendations from the Board concern the Site Characterization Plan, ongoing Exploratory Studies Facility (ESF), and conceptual repository design.

Recommendation 1:

The Board recommends that the DOE revise its program to include earlier underground excavation. Surface-based drilling alone will not reveal all the important hydrogeologic characteristics of the many important structural geologic features. Underground access across key geologic features to visually examine and evaluate those features is critical to determining site suitability and should be made an early goal regardless of budgetary constraints.

Response:

DOE recognizes the importance of conducting both surface-based and subsurface investigations to support the evaluation of suitability of the Yucca Mountain site. The schedule for such investigation and evaluation is constrained by various factors, including program funding. As discussed in the January 7-8, 1992, meeting with the Board, program planning and allocation of available funds are based on the goal of meeting the two primary programmatic milestones: to begin receipt of waste in 1998 and to begin disposal of waste in 2010. These two milestones are of equal importance in fulfilling the mission of OCRWM.

Under the fiscal year 1992 budgetary constraints, DOE chose to advance the ESF design effort as much as possible while still maintaining the surface-based testing activities. Surface-based testing is essential to obtain needed data, address early site suitability issues, and sustain scientific progress. The design and construction of the ESF is a major program effort that will require a multiyear commitment of significant resources in order to achieve any useful results in the near term. Current budget restrictions will not allow OCRWM to fund the ESF-related activities required to move this element of the program forward in a coherent manner, and at the same time fund ongoing site characterization activities that must be maintained to ensure program continuity and regulatory compliance (e.g., seismic, hydrologic, and environmental monitoring).

DOE agrees that underground access is essential to site characterization. DOE expects that a large portion of the projected future increases in program funding will be allocated to ESF design and construction in order to gain underground access to Yucca Mountain as quickly and as efficiently as practical.

Recommendation 2:

The Board recommends that 16- to 20-ft tunnel diameters be considered for the ramps and exploratory tunnels. Smaller tunnels would be more in line with the requirements of an exploratory facility and offer additional benefits, such as reduced excavation volumes, lower ventilation requirements, and smaller surface facilities. Smaller tunnel-boring machines, which are not only less expensive but also more available in the marketplace, could be used. Finally, the increase in tunneling advance rates due to smaller tunnels would provide additional schedule savings.

Response:

DOE recognizes that potential near-term cost and schedule savings can be realized through the use of smaller diameter tunnels for the ESF. Other factors, however, must be considered in the context of overall program requirements. These factors include: testing strategies, the potential for test-to-test interference; sealing strategies; operational safety; and the potential impacts of underground exploration on repository design and on the ability of the natural barrier to isolate waste. In order to minimize the adverse impacts of exploration and characterization activities, the ESF design and layout must be integrated with the potential repository design. If smaller diameter tunnels are used for the ESF, and later have to be reamed to a diameter sufficient for the repository operational requirements should the site be found suitable, a range of safety, technical, and cost and schedule issues may be introduced. For example, removal of ESF ground support prior to reaming may increase risk of injury. Also, enlargement of the ESF openings, and eventual procurement of larger tunnel boring machines, includes increased costs that are likely to more than offset the near-term cost savings.

Ramp and drift diameters were analyzed during the revisions to the ESF Title I designs, and they will continue to be evaluated while the requirements are refined in Title II design. The repository Advanced Conceptual Design will be developed in parallel with the ESF Title II design. Multiple alternative concepts will be evaluated in this process with interfaces being coordinated with the ESF designs.

Recommendation 3:

*In light of budgetary uncertainty, the DOE should consider the development of contingency plans for fiscal year 1993 and beyond for reaching the major milestones of the site-characterization program. Such plans should include early underground access from at least one portal (e.g., the south portal) and its access ramp. Key geologic features should be crossed at various locations above and below the repository horizon. In this way, **both** subsurface and surface-based site characterization can proceed to some extent, even in times of budgetary uncertainty.*

Response:

As discussed in the January 1992 meeting on budget considerations, the design and construction of the ESF is a major program effort that will require a multiyear commitment of significant resources. DOE has chosen to fund the ESF design activities as much as possible while still maintaining an active surface-based testing program.

At the same time, DOE is exploring different options for obtaining the earliest possible access to key underground units and features in a way that is consistent with achieving overall program goals. Several of these options and concepts, including an early exploratory pilot program for limited underground exploration, the phased development of the ESF as currently conceived, and specific suggestions from the Board were discussed at the January 1992 meeting. Within budgetary constraints, DOE will continue to evaluate these and other options in terms of program goals, and Nuclear Regulatory Commission (NRC) and environmental requirements.

Recommendation 4:

The Board encourages the use of a structured probabilistic approach that not only can serve to provide useful estimates of volcanic hazard at Yucca Mountain, but also can help discriminate between those differences in input assumptions that have a significant impact on volcanic hazard and those that do not.

Response:

DOE's volcanism studies are based on a structured probabilistic approach that is consistent with the Board's recommendation. A technical paper describing this approach is presently undergoing internal review prior to publication. This paper reviews recurrence models of volcanic events and attempts to constrain the estimate of the recurrence rate for the Yucca Mountain region using a simple Poisson model, and also by analogy to the recurrence rate of volcanic events for active volcanic fields in southern Nevada and adjacent California areas. This paper is being published as part of an effort to obtain a consensus on the elements of a probabilistic approach to volcanism studies.

The strategy for implementing a probabilistic approach to the volcanism issue for the Yucca Mountain site is described in study plan 8.3.1.8.1.1, "Probability of Magmatic Disruption of the Repository." A second report on the structural controls of volcanic activity will also be completed this fiscal year.

Recommendation 5:

The Board urges the DOE to place added emphasis on the evaluation of volcanic vulnerabilities and consequences. As with other natural hazards, the likelihood and magnitude of adverse consequences, options for their avoidance through engineering design, and not just the occurrence of natural phenomena alone, should be considered.

Response:

DOE agrees that volcanic vulnerabilities and consequences need to be evaluated; this is a part of the planned site characterization program. The likelihood and magnitude of adverse consequences and options for their avoidance will also be considered.

Initial work on the consequences of magmatic disruption of a repository was completed in the early 1980's. DOE reviewed possible volcanic scenarios for magmatic disruption of a repository (Crowe et al., 1983) and provided preliminary assessments of radiological releases associated with a disruptive event (Link et al., 1982). Revised consequence analyses were re-initiated in 1991 and are continuing this year. The level of effort for this work will increase in 1993 as the data required to resolve the issues is further refined and constrained.

The plans for assessing the effects of magmatism on a repository at the candidate Yucca Mountain site are to be detailed in study plan 8.3.1.8.1.2, "Effects of a Volcanic Eruption Penetrating the Repository." The first of the three classes of consequences to be considered are those consequences associated with small-volume basaltic eruptions penetrating the repository. The thrust of this work is to determine if the volume of waste that could be erupted on to the surface by a magmatic event can be constrained. This approach relies on data collected from analogue volcanic centers in the southwestern United States. The perspective is probabilistic. The study attempts to establish the likelihood of surface radionuclide releases according to the depth of burial of radioactive waste associated with the magmatic disruption of a repository. These values will be coupled with the calculations of the probability of a future magmatic event intersecting the potential repository and the recurrence rate of volcanic events. The second class of consequences considered is those associated with the subsurface effects of magmatic activity within the repository block, regardless of whether such activity produces a surface eruption. The emphasis of this examination will be determining whether subsurface activity could accelerate the release of waste through coupled processes to the accessible environment. The third class of consequences being evaluated is those associated with the physical processes of magmatism in the Yucca Mountain region, including melt generation, storage, ascent, and eruption. The goal of this work is to provide a mechanistic foundation for predictions of future volcanic activity. This work may be used to assess calculations of the radiological releases of radionuclides if the first class of studies is insufficient to resolve the volcanism issue.

While it appears technically feasible to mitigate the effects of future volcanism through engineering design, DOE believes such action is not warranted by the current estimates of the likelihood of magmatism impacting the waste isolation capabilities of the repository. If the studies described above indicate that the probability and consequences of magmatic disruption of the repository are significant enough to warrant consideration of avoidance by engineering design, DOE will conduct such engineering trade studies.

HYDROGEOLOGY AND GEOCHEMISTRY

The following recommendation pertains to the hydrogeology and geochemistry studies of the proposed repository site and the test programs to verify the expected behavior.

Recommendation 6:

The Board recommends that the DOE carry out sensitivity studies to determine how limitations in instrument accuracy could affect estimates of water flux and performance in the unsaturated zone. This information should be used to refine testing strategies, determine the need for new instrumentation, and provide a realistic estimate of the DOE's ability to adequately characterize the unsaturated zone.

Response:

Sensitivity analyses related to limitations in instrumentation and testing methods are an integral part of each unsaturated zone study and are a major part of the overall interpretive study of the unsaturated zone that will be described in study plan 8.3.1.2.2.9, "Site Unsaturated Zone Modelling and Synthesis." The general approach used by the stochastic modeling activity recognizes that the accuracy of a model representation depends on the adequacy and completeness of the underlying conceptual model as well as on the presence of computational and data-related error. The adequacy and completeness of the conceptual model will be established prior to construction of a final hydrogeologic model for the site. Approximate quantitative bounds of uncertainty for the site moisture-flow model will be estimated through a combination of classical statistical and geostatistical data analyses, sensitivity analysis studies, and stochastic modeling. Limitations and uncertainties associated with testing methods will be considered in this process.

ENGINEERED BARRIER SYSTEM

The following Board recommendations to DOE pertain to the design of the Engineered Barrier System (EBS) and its contribution to the overall system waste isolation performance.

Recommendation 7:

Engineered barriers must be viewed as an integral part of the repository system. Studies of the potential contribution of engineered barriers, such as multi-purpose canisters, should not be deferred until a later date. EBS development and testing should be funded continuously and at a level sufficient to evaluate its contribution to long-term predictions of repository behavior.

Response:

DOE understands the Board's concerns that continued reductions in funding in the EBS program may affect the proposed timetable for site evaluation and repository development if the site is found suitable. The need to evaluate the potential contribution of the EBS to long-term predic-

tions of repository performance is fully recognized. DOE also recognizes that the development of the waste package requires long-term corrosion testing of candidate materials and that there is no work currently being done in this area.

DOE is fully cognizant of the need for additional effort in waste package materials and design, and in the design and testing of other parts of the EBS. However, current budgetary constraints have curtailed much of the development effort for now. As discussed in the January 7-8, 1992, meeting with the Board, higher program priorities associated with surface-based testing in support of site suitability evaluation, and the monitored retrievable storage and transportation activities in support of waste acceptance in 1998 have prevented allocating additional funds to the EBS development effort. DOE intends to begin the Advanced Conceptual Design phase of EBS and repository design studies in October 1992. A major increase in funding for EBS design is being planned for future years to meet program milestones.

Recommendation 8:

The Board recommends that the DOE consider organizing a follow-up meeting of EBS workshop experts plus other selected participants as early as possible in 1992. The purpose of this follow-up meeting would be to review and consolidate the recommendations and comments about EBS concepts gathered at the DOE's June 1991 workshop.

Response:

DOE concurs with the Board that the EBS Concepts Workshop held in Denver, CO, in June 1991 was useful. The concepts and evaluations derived from that workshop have influenced the thinking of the personnel involved in the pre-advanced conceptual design development of the EBS. As stated in the DOE's "Extended Summary Report on Engineered Barrier System Concepts Workshop," another workshop is planned for fiscal year 1993. This workshop would concentrate on those concepts selected by DOE for the ACD in order to provide a more focused and thorough evaluation of the candidate ACD concepts.

ENVIRONMENT AND PUBLIC HEALTH

This Board recommendation pertains to the manner by which DOE will demonstrate compliance with NRC regulations with respect to system performance.

Recommendation 9:

The Board recommends that the DOE seek clarification from the NRC of the procedures by which alternative levels of subsystem performance could be authorized.

Response:

DOE recognizes the potential need for developing procedures by which alternative levels of subsystem performance may be introduced into a potential licensing strategy. Under 10 CFR Part 60.113(b), "... the Commission may approve or specify some other radionuclide release rate, designed containment period, or pre-waste emplacement ground water travel time, provided that the overall system performance objective, as it relates to anticipated processes and events, is satisfied." The burden is on DOE, based on its evaluation of the site and engineered components of the repository system, to present data and analyses that would support approval by the Commission of alternatives to the existing subsystem performance objectives. As site characterization data are obtained and analyzed, and the iterative performance assessments become more refined, DOE will be able to identify potential alternatives to the existing subsystem performance objectives if necessary. Discussions of such alternatives and the supporting evidence will be undertaken with the NRC at that time as part of the pre-licensing interactions.

RISK AND PERFORMANCE ANALYSIS

The following Board recommendation pertains to the methodology for utilizing expert opinion in conducting the performance assessment of the potential repository.

Recommendation 10:

The DOE needs to refine further its methods for assessing expert judgment, and the DOE and the NRC need to attain agreement on the potential use of experts prior to beginning the licensing process. The Board suggests that a workshop be held in 1992 to examine the use of expert judgment in the DOE's current performance assessment and in the performance assessment exercises carried out by other organizations (NRC, Electric Power Research Institute, and Golder Associates), and to propose specific recommendations for the improvement of this part of the performance assessment process in subsequent iterations.

Response:

DOE agrees that it would be useful to reach a common understanding with NRC regarding the use of experts and the role of expert judgment prior to beginning the licensing process. The results from the working group on the use of expert judgment that was convened by NRC's Advisory Committee on Nuclear Waste should also provide useful input to achieving this understanding. DOE is planning a workshop on expert judgment, as recommended by the Board, to be held in the fall 1992 timeframe.

DOE intends to preserve the flexibility to define the level of expert judgment or peer review to be applied during site characterization for specific cases when the use of subjective methods may become necessary. With respect to recent activities noted by the Board, DOE has relied on consultants who are specialists in the use of expert judgment in the various tasks where expert judgment has played a key role. These include the Exploratory Studies Facility Alternatives Study, the Test Prioritization Task, the Calico Hills Risk Benefit Analysis, and the Early Site Suitability Evaluation. In each case, expert judgment was a key component of the evaluation, although the tasks varied in the degree to which formal elicitation was used. Lessons that have been learned from these tasks are being incorporated in plans for similar activities in the future.

The Total System Performance Assessment models constructed by both Sandia National Laboratories and Golder Associates for DOE benefited from the work of staff members specializing in the elicitation of expert judgment. In addition, both performance assessment teams have demonstrated how judgments can be merged with existing data to further constrain modeling. With respect to selection of models and to determination of probability distributions of model parameters, the elicitation has substantially enhanced the comprehensiveness of performance assessments of the Yucca Mountain site.