



Department of Energy

Washington, DC 20585

September 18, 1991

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 Third Report to the U.S. Congress and the U.S. Secretary of Energy that was issued on May 28, 1991. Our responses address the Board's 15 recommendations and one conclusion in the 7 broad areas (structural geology and geoen지니어ing; engineered barrier system; transportation and systems; environment and public health; quality assurance; hydrogeology and geochemistry; and international activities) covered in your report.

I am pleased to note, as reflected in our responses to the Board's May 1991 report and preceding reports, that our strategies, activities, and plans are highly consistent with the Board's recommendations. This consistency helps build confidence that our technical program is well conceived and is responsive to constructive suggestions provided by independent expertise such as that of the Board. A sound program, as a result of comprehensive critique and review, is essential as we embark on new activities to evaluate the Yucca Mountain site and to design the pre-disposal system.

As you know, we recently began, for the first time since 1986, new surface-disturbing activities at the Yucca Mountain site. This work begins our effort to evaluate the suitability of the site as soon as possible. I anticipate that the plans, activities, and findings for this effort will be a significant part of the Board's agenda in the future.

We have also initiated work leading to design and integration of the transportation and storage systems, with the objective of meeting the Secretary's goal to begin spent fuel receipt from reactors in 1998. We expect that these activities will also be the subject of constructive review and guidance from the Board.

Our program activities are being selected and implemented in accord with strategic principles recently established through intensive effort by our staff and with the participation of affected and interested parties. These

principles, together with our policies and strategic plans, are set forth in our Draft Mission Plan Amendment which is soon to be issued for public comment. I would like to take this opportunity to invite the Board's comments on this highly important document.

We greatly appreciate the Board's reviews and advice on the content and performance of our program. The Board has had significant positive impact on our technical progress, and we look forward to its continuing contributions.

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
Third Report to the U.S. Congress and the U.S. Secretary of Energy
May 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 three reports to date. The third report, issued on May 28, 1991, includes 15 recommendations in 6 broad areas: (1) structural geology and geoengineering; (2) the engineered barrier system; (3) transportation and systems; (4) the environment and public health; (5) quality assurance; (6) hydrogeology and geochemistry. Also included in the third report is a conclusion supporting a seventh broad subject area, international activities.

These recommendations and DOE's responses are presented in this report. Each recommendation is quoted verbatim from the Board's report of May 28, 1991, and is followed by the response.

STRUCTURAL GEOLOGY AND GEOENGINEERING

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

Recommendation 1:

The DOE should reexamine its test plans to ensure that the saturated zone of the Calico Hills unit and Prow Pass member will be adequately evaluated - considering its appreciable contribution to waste isolation as determined in the CHRBA study.

Response:

DOE regards the saturated zone to be one component of the natural barrier system at the Yucca Mountain candidate site. DOE recognizes that present day and expected future conditions and processes within the saturated zone may sufficiently retard aqueous-phase radionuclide transport to satisfy all applicable rules and regulations governing allowable releases to the accessible environment from the repository system. In this regard, it should be recalled that when the Yucca Mountain candidate site was initially identified for evaluation as a potential site for a repository, the conceptual design located the repository within the saturated zone. Only when it

was recognized that thick unsaturated zones in arid environments could offer appreciable advantages for waste containment and isolation was emphasis redirected from the saturated zone to the unsaturated zone at the Yucca Mountain candidate site. In shifting emphasis, however, DOE did not intend to ignore or otherwise underrate the waste isolation capabilities of the saturated zone. The site characterization program as described in the SCP and its associated Study Plans is intended to provide the data needed to assess the waste isolation capability of the saturated zone beneath and beyond the Yucca Mountain candidate site. These data will be derived from borehole cores, from hydraulic and tracer testing in boreholes penetrating the saturated zone, and from samples and testing in the Exploratory Studies Facility.

Strictly speaking, the Calico Hills Risk Benefit Analysis (CHRBA) study did not "determine" that the saturated zone within the Calico Hills and Prow Pass units would make an "appreciable contribution" to waste isolation. Rather, the CHRBA study used expert judgment as a basis for reinterpreting the discussion of saturated zone groundwater travel time presented in Section 3.9.4.2 of the SCP. The SCP analysis of groundwater travel time was based on a set of highly-conservative "fast-pathway" assumptions that neglected both mechanical and geochemical processes of radionuclide retardation. The CHRBA study elicited judgments of effective retardation factors appropriate to the saturated zone within a five kilometer radius of the potential repository. The numerical retardation factors that were elicited from the technical experts represent composite values for radionuclide transport within the saturated zone and are not referenced to any particular pathway or hydrogeologic unit or units. These retardation-factor values were expressed probabilistically, were not based on any explicit performance calculations or assessments, and consequently, were not deterministic. The CHRBA results merely reflect the expectation that when appropriate allowance is made for the effects of radionuclide retardation, the saturated zone at the Yucca Mountain candidate site is likely to significantly impede radionuclide transport from the unsaturated zone to the accessible environment. This expectation, however, will be evaluated quantitatively as part of the overall site characterization process.

Recommendation 2:

The DOE should continue with the preliminary design of the ESF on the basis of the selected and optimized version of the three highest-ranked options from the ESF alternatives study.

Response:

Currently, the Yucca Mountain Site Characterization Project Office (YMP) is completing the review and approval of an ESF Title I Design Summary Report based on the Reference Design Concept, a synthesis of the top three choices from the ESF Alternatives Study, Options 30, 23, and 24. Option 30 is characterized by dual ramp accesses to an ESF underground layout in the southern end of the potential Geologic Repository Operations Area (GROA). Option 23 is similar to Option 30 with an ESF underground layout in the northern end of the potential GROA. Option 24 combines shaft and ramp access to an ESF layout in the same location as Option 23.

The resultant ESF Reference Design Concept is composed of a north ramp (Access 1) and a south ramp (Access 2) connecting to exploratory drifting in both the Calico Hills unit and overlying Topopah Spring Member. The Calico Hills drifting is planned to characterize the ability of the unit to act as a radionuclide barrier beneath the potential repository horizon. Drifting in the Topopah Spring Member (TSW1) will include the main ESF underground layout for charac-

terization of the potential repository horizon and evaluation of repository scale openings and components. The principal concentration of drifting for the main ESF underground layout is located in the northeast corner of the potential GROA in the TSW1 horizon. Additionally, allowance has been made in the Reference Design Concept for an optional vertical shaft (Access 3) to be used solely for testing in the strata overlying TSW1.

The approved ESF Title I Design Summary Report will be the basis for the Title II design effort.

Recommendation 3:

The DOE should continue with repository conceptual design throughout the design phases for the ESF. Different geometric layouts and thermal-loading alternatives for the repository should be explored.

Response:

DOE agrees that continuation of the repository conceptual design process in parallel with the ESF design phases is desirable. However, budgetary constraints have required prioritization of the program elements and, with early site suitability evaluation as the current priority, DOE has chosen to concentrate on surface-based site characterization activities. Continuing repository design efforts are concentrating on those items critical to the ESF design and the site characterization efforts. For example, the proposed repository/ESF interface drawings are being developed, as are computer models to determine the impacts of the ESF envelope on the GROA. Additionally, the potential repository conceptual design in the SCP will be modified as ESF Title II design phases are completed.

ENGINEERED BARRIER SYSTEM

The following Board recommendations to DOE pertain to the design of the Engineered Barrier System (EBS) and the content of the applicable licensing regulations.

Recommendation 4:

High priority should be assigned to developing a more robust engineered barrier system. A workshop on engineered barriers, which was recommended in the Board's Second Report and which has been scheduled for June 18-20 in Denver, Colorado, is a logical first step.

Response:

DOE agrees that the development of a robust Engineered Barrier System (EBS) is desirable. However, current budgetary constraints have curtailed much of the development effort at this time. Higher program priorities, including site characterization, waste acceptance in 1998, and the transportation system infrastructure, prevent allocating additional funds to the EBS development effort. DOE will continue to develop the EBS following the structure outlined in the Waste

Package Plan (WPP) and the methodology presented at the DOE-sponsored Engineered Barrier System Workshop of June 18-20,1991, as program funding allows. The schedule information in the WPP has been superseded by other program priorities.

The information presented at the workshop is currently being reviewed by DOE and its contractors to identify technologies and concepts that require further evaluation or are appropriate for potential inclusion in the EBS. DOE will continue to keep the Board apprised of the new developments.

Recommendation 5:

The Board recommends that the DOE seek clarification of some NRC regulations. The NRC should be able to provide definitions for terms like "substantially complete containment" and the "proof to be required to demonstrate such containment".

Response:

DOE and the Nuclear Regulatory Commission (NRC) meet periodically to establish topics and schedules for interactions. DOE has discussed with NRC the need to identify and resolve issues, including the interpretation of regulatory terms and requirements, as early as possible to prevent unnecessary delays during licensing. DOE is presently evaluating various regulatory and technical issues to identify the most appropriate timing and approach for DOE action to seek resolution. The approaches being considered range from rulemaking proceedings initiated either by NRC or by petition from DOE (e.g., the DOE petition for rulemaking to establish an accident dose limit for repository operations) to submittal of topical reports by DOE on specific issues for formal review by NRC and possibly by the Advisory Committee on Nuclear Waste (e.g., DOE has proposed to submit a topical report on investigation of earthquake and faulting hazards at the site). DOE intends to interact with NRC in a manner which is conducive to convergence and closure of issues, such as those cited above.

TRANSPORTATION AND SYSTEMS

The following Board recommendation concerns the interactions and interfaces of the various components of the overall waste handling system.

Recommendation 6:

A workshop should be scheduled on ways to minimize the handling of waste in the life-cycle process. The workshop should address the interactions among the major system components - storage, transportation, and disposal. The scope should include potential technologies, possible regulatory impediments, and institutional incentives and barriers to such an integrated system.

Response:

DOE agrees that a workshop would be helpful in identifying and resolving issues surrounding multiple handling of waste, but believes such a workshop should be preceded by a system study. The study would address the issues identified by the Board, including potential technologies, possible regulatory impediments, and institutional incentives and barriers. Results of the study would then be used as the focus of a workshop to address the evaluated issues.

DOE will initiate planning for the system study and subsequent workshop to discuss ways to minimize waste handling in the life-cycle process, as recommended by the Board. DOE will work with the Transportation and Systems Panel and staff to identify specific topics for the study and potential participants for the workshop.

ENVIRONMENT AND PUBLIC HEALTH

These Board recommendations pertain to increasing the public knowledge of the program, including non-DOE experts in the decision-making process, and updating the regulations responsible for ensuring public health and environmental safety.

Recommendation 7:

The DOE should consider developing a comprehensive regional program to expand the public's understanding of the potential risks associated with the development of a high-level nuclear waste repository, as well as of other nuclear and non-nuclear activities. Special efforts should be made to develop a dialogue involving non-DOE experts.

Response:

DOE believes that the best way to expand the public's understanding of the potential risks of managing radioactive wastes is to interact and communicate more effectively with parties concerned with the program. DOE is taking several initiatives toward this end.

Broadening participation of affected governments, interested parties, and the public in decision-making

DOE is committed to involving external parties in the development of policy alternatives before decisions are made. A "Director's Forum" is being established for representatives of affected governments, interested parties, and the public to meet with OCRWM to discuss upcoming program decisions and policy alternatives. DOE will also seek to build constructive working relationships with external parties through the expanded use of cooperative agreements and other meetings outside the Forum. To support these interactions, DOE will identify issues and technical milestones that are potentially of concern to external parties.

Strengthening two-way communication with the general public

Effective two-way communication with the public is essential if the program is to succeed. The "public" is made up of numerous audiences with unique backgrounds and concerns. DOE is improving its information products by identifying specific audiences and their concerns, developing appropriate messages, and using suitable information channels to convey them. Training will also be provided to help OCRWM communicate more effectively, both orally and in writing. DOE will seek opportunities to address a wider range of organizations and systematically evaluate feedback from public speaking engagements. DOE will also reach out to local and specialized media, and make OCRWM more available for interviews and informal discussions.

Maintaining the support of the scientific community

Earning the confidence of the scientific community is fundamental to earning the confidence of the larger public. From the inception of the program, DOE has worked hard to interact with the scientific community and will continue to do so. OCRWM participates extensively in conferences sponsored by scientific, technical, and professional organizations. Our participation serves not only to keep the scientific communities informed, it also exposes our work to their scrutiny and encourages independent technical comment.

Engaging the education community

Building public understanding of radioactive waste management is a long-term effort. This understanding must be developed within the broader context of energy and environmental concerns. To help the public make informed judgments about the risks of producing energy and managing its by-products, DOE is developing a variety of educational programs. These activities are integrated with the overall DOE effort to promote understanding and awareness of science at all levels, improve teachers' skills, encourage careers in science and engineering, and develop curricula materials.

In summary, these initiatives will establish an ongoing process for interacting and communicating more effectively with external parties. This, in turn, will provide a solid foundation for building public understanding of risks.

Recommendation 8:

The EPA and the NRC should be encouraged to modify and clarify 40 CFR 191 and 10 CFR 60, respectively. The regulations should be risk based, fully protective of public health and the environment, but not too prescriptive. In addition to being consistent and mutually compatible, they should be presented in a clear and understandable manner and be applicable to and defensible in the licensing arena. Furthermore, they should reflect current internationally accepted environmental standards and be compatible with the uncertainties intrinsic to long-term geologic processes.

Response:

DOE has encouraged the Environmental Protection Agency (EPA) and NRC to improve their regulations with respect to critical terms and concepts and the degree to which compliance with complementary, but independent, environmental standards and subsystem performance objectives can be successfully demonstrated. DOE has communicated its concerns with respect to regulations to NRC and EPA via comments on proposed rules (e.g., 40 CFR 191), petitions for

rulemakings (e.g., Accident Dose Criteria of 10 CFR 60), and other formal correspondence (e.g., comments on NRC Update of Regulatory Strategy and Schedules for the High-Level Waste Repository Program dated June 7, 1990 SECY 90-207). DOE also agrees with the Board's recommendation that the regulations should be risk based, and fully protective of worker and public health and safety, and of the environment.

QUALITY ASSURANCE

The following Board recommendations concern the content and implementation of the DOE Quality Assurance (QA) Program.

Recommendation 9:

The Board praises the DOE for initiating a two-way process to identify and resolve QA implementation issues that have been identified by DOE management and researchers. The Board concurs with the DOE's QA managers that the QA process should not be coupled with highly detailed management/administrative procedures. The Board recommends that the DOE continue this process to ensure that the program considers the concerns of the scientists.

Response:

DOE continues to strive for improvement in the process of addressing the concerns of the scientific community with respect to QA implementation. Recent changes in the QA program have been evolutionary, and will continue to be dependent on acquired experience and exercise of applicable procedures. DOE will continue to address management and administrative issues for the most effective and efficient manner in which to conduct a complex, highly-integrated, and research-oriented technical program that must operate in a regulatory environment.

Recommendation 10:

The Board recommends that the DOE move in a timely way to implement the measures agreed to at the QA workshops.

Response:

DOE agrees that measures from the QA workshops should be implemented in a timely manner. Several of the measures agreed to at QA workshops have been implemented and corrective measures have been institutionalized through revised procedures.

Recommendation 11:

The Board recommends that the QA grading process be improved to provide for greater flexibility in accommodating exploratory research.

Response:

DOE appreciates the Board's encouragement and support for efforts to resolve QA implementation issues. The QA grading process that had been used by the project until 1990 was streamlined to provide greater management flexibility. DOE monitors the conceptual and procedural aspects of this process on a continuing basis, and seeks opportunities to further streamline the QA grading process, while still meeting the regulatory requirements incumbent on the program. The QA workshops on grading have addressed the issue, and the participants have presented a list of recommendations to DOE management. On June 18, 1991, DOE issued a "QA Grading Vision Statement" that responded to the workshops' recommendations. DOE believes that, by these efforts, it is providing for greater flexibility in accommodating exploratory research.

HYDROGEOLOGY AND GEOCHEMISTRY

The following recommendations pertain to the hydrogeology and geochemistry of the proposed repository site and the test programs to verify the expected behavior.

Recommendation 12:

The Board strongly supports the DOE's new policy to improve internal program communication, review, and planning between DOE managers and scientists involved in related disciplines in the program. The DOE should, however, implement a programwide plan and policy for routine external peer review.

Response:

DOE is continually working to improve communication among project participants. New efforts in this area include conducting periodic meetings between participants doing similar work such as the geochemical work related to the far-field at Los Alamos National Laboratory and the geochemical characterization of the near-field environment by Lawrence Livermore National Laboratory. In addition, DOE is conducting topical meetings where individuals representing all participants are invited to attend. One such meeting was conducted July 29-31, 1991, on the topic of groundwater chemistry.

DOE has traditionally used external peer reviews in the high-level waste program and will continue to do so. DOE has just completed a major peer review of the unsaturated zone hydrology program and has formed a peer review panel for studies of rock mechanics. DOE also intends to establish a formal process for the selection of the members of the peer review panels in order to ensure independent and objective reviews; this process may be similar to that already used by the National Academy of Sciences. DOE will continue to make its peer review process as open as possible and document the program changes that result from peer reviews. Further peer reviews in other technical areas, such as geochemistry, will be considered on a case-by-case basis.

Recommendation 13:

Recent communication has shown that the DOE is committed to studying the applicability of laboratory measurements in geochemistry and hydrology to site characterization. The Board also is concerned with this applicability and recommends that the DOE continue to address it.

Response:

DOE has been concerned with whether data generated in a laboratory is valid for making predictions about radionuclide migration under natural conditions at Yucca Mountain. While laboratory measurements are easy to perform, the direct applicability of these tests for performance assessment analyses is uncertain due to the differences in scale, rock/waste ratios, and the geologic, geochemical and hydrogeologic representatives of the laboratory samples. DOE is planning field tests for both the saturated and unsaturated zones to evaluate sorption models and parameters. The in situ sorption values determined under natural conditions at Yucca Mountain will be compared with laboratory results. This will assist in validating the conceptual models for radionuclide transport. In the case of the saturated zone testing, multiple experiments will be conducted to compare calculated values of transport with measured values. Unsaturated zone testing will utilize the same methods, but the duration of these experiments will be considerably longer. One of the key constraints on field testing is the restrictions on using radionuclides at the site. Potential analogue tracers will be investigated and characterized in order to conduct field experiments that provide data on radionuclide transport.

The study plans that relate to these activities are the Testing of the C-Hole Sites with Reactive Tracers, (8.3.1.2.3.1.7,R1), which has been issued by DOE and was sent to NRC on April 10, 1991, and the Field Validation Testing of Radionuclide Transport (8.3.1.3.7.2), which is currently being prepared.

Recommendation 14:

The Board believes that the DOE's proposed plan for applying experimental radionuclide sorption results to performance assessment at Yucca Mountain is well conceived. However, inadequate design, documentation, and analysis of many published radionuclide sorption results make it doubtful that they can be used to define conservative sorption behavior. The Board suggests that the DOE model future experimental sorption results using a surface complexation approach. This would lead to a more comprehensive understanding of an explanation for these results, without which we cannot have confidence that such results represent conservative sorption behavior for a particular radionuclide.

Response:

DOE agrees with the Board's suggestion that the sorption program should use the surface complexation approach to modeling experimental sorption results. DOE has used in some cases and will use in the future, the surface complexation approach to investigate the mechanisms by which different radionuclides adsorb onto mineral surfaces. However, DOE believes that the surface complexation approach cannot, at this time, be generalized to predict sorption behavior in complex electrolyte systems and other multi-mineralic systems. The surface complexation approach will be used as part of the proposed minimum K_d strategy that involves a single mineral.

Currently, work is ongoing both at Los Alamos National Laboratory and Stanford University using the surface complexation approach in the investigation of Np sorption behavior on the single minerals of hematite, quartz, and albite.

DOE also agrees that many of the published sorption data are not documented well enough to permit their use in performance assessment calculations. However, much of the YMP-sponsored sorption data is useable because unlisted parameters are known and are being documented. At this time, all sorption experiments are performed under a qualified QA program assuring adequacy of experimental design, documentation, and traceability.

Recommendation 15:

The Board endorses the DOE's intention to perform some future sorption experiments under unsaturated conditions and to use waters with compositions that might be expected at the site after waste emplacement.

Response:

DOE intends to conduct sorption experiments under unsaturated conditions by passing solutions through columns of solid materials. The techniques of using both vacuum and a centrifuge to maintain unsaturated conditions are being investigated to determine their differences and relative feasibility. The results of a literature review will be completed at the end of 1991 and experiments will be conducted when adequate resources become available.

DOE is concerned about the different compositions of ground water at Yucca Mountain, both naturally-occurring and changes induced by waste emplacement, and how these differences affect not only sorption behavior but also the solubility and speciation of radionuclides. A groundwater chemistry interaction meeting was held on July 29-31, 1991, to further our understanding of this important technical issue.

DOE is presently using groundwater compositions in the experimental programs that may bracket the range of naturally-occurring groundwater compositions. As actual water chemistry data become available, these compositions will be evaluated and any necessary changes to the experimental program will be implemented.

INTERNATIONAL ACTIVITIES

The following response is to the Board's conclusion on International Activities contained in its Third Report.

"The Board's experience has shown that much can be gained by remaining apprised of technical activities underway in countries that are developing and implementing high-level waste disposal programs." (NWTRB Third Report Page 41, Sec. B, para. 1)

DOE concurs with the Board's conclusion that the U.S. has much to gain by remaining involved in international developments regarding high-level waste disposal programs. DOE's Office of Civilian Radioactive Waste Management (OCRWM) has conducted an active program of

international activities over the years, involving a number of mechanisms for participation, including bilateral agreements, multi-lateral agreements, and participation in international organizations such as the Organization for Economic Cooperation and Development's Nuclear Energy Agency and the International Atomic Energy Agency. Within these mechanisms, information is acquired through a wide range of activities, including cooperative testing and technology development efforts involving laboratory, underground and surface-based field testing, safety assessment model development and testing, personnel exchange, information exchange, as well as participation in working groups focused on specific subjects.

In an effort to further enhance the integration of international work into the U.S. domestic program, OCRWM has established an International Program Working Group with representation from all of its program offices and with responsibilities to periodically review and evaluate OCRWM's international activities and their contribution to the U.S. program. OCRWM's efforts to remain informed of current foreign developments in nuclear waste management are also enhanced by our International Program Support Office, which publishes a variety of documents (highlights reports, national briefing summaries, international fact books, topical reports) which are intended to keep the U.S. program apprised of significant international developments relevant to nuclear waste management.

Currently, OCRWM is actively pursuing a number of specific cooperative agreements with other nations. Approval is being sought for Project Agreement 3 (an extension of a testing program initiated with Switzerland in 1985), which focuses on fracture flow, diffusive transport, and geophysical measurement techniques. Also, we are finalizing Subsidiary Agreement 2 with Canada, which will include a broad spectrum of laboratory and field testing, as well as safety assessment activities. In addition, discussions have been initiated with Sweden regarding collaboration in its Hard Rock Laboratory. We will continue to pursue additional opportunities for nuclear waste management cooperation with other nations.