



UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD
2300 Clarendon Boulevard, Suite 1300
Arlington, VA 22201

December 30, 2004

The Honorable J. Dennis Hastert
Speaker of the House
United States House of Representatives
Washington, DC 20515

The Honorable Ted Stevens
President Pro Tempore
United States Senate
Washington, DC 20510

The Honorable Spencer Abraham
Secretary
U.S. Department of Energy
Washington, DC 20585

Dear Speaker Hastert, Senator Stevens, and Secretary Abraham:

This is the U.S. Nuclear Waste Technical Review Board's second report of 2004, submitted in accordance with provisions of the Nuclear Waste Policy Amendments Act of 1987, Public Law 100-203.

Congress created the Board to evaluate the technical and scientific validity of activities undertaken by the Secretary of Energy in implementing the Nuclear Waste Policy Act as amended, including the development of a repository for disposing of spent nuclear fuel and high-level radioactive waste at Yucca Mountain in Nevada and the packaging and transportation of such waste. Consistent with its congressional mandate, the Board has reviewed technical and scientific work undertaken by the Department of Energy (DOE) in 2004 and has conveyed its recommendations and observations in letters to the director of the DOE program. Those letters and all other Board documents are available on the Board's Web site: www.nwtrb.gov.

In the following paragraphs, the Board presents a brief overview of areas where it believes that the DOE has made progress, issues requiring additional attention, and topics on which the Board will focus in 2005. A more detailed discussion of these issues is presented in the enclosure.

Areas of Progress

On the basis of information presented by the DOE at meetings in 2004, the Board believes that progress has been made in several of the areas on which the Board commented in its letters to the DOE. For example, a key corrosion issue raised by the Board in 2003 was addressed by DOE data and analyses, indicating that tunnel conditions during the thermal pulse

will likely not lead to the initiation of localized corrosion of the waste packages due to deliquescence of calcium chloride. The Board is encouraged by the DOE's efforts in making its earthquake ground-motion estimates more realistic and in completing an aeromagnetic survey that could shed light on igneous activity in the Yucca Mountain area. The DOE also appears to have made headway in developing a systematic approach to planning the transportation of spent nuclear fuel and high-level radioactive waste.

Areas Requiring Attention

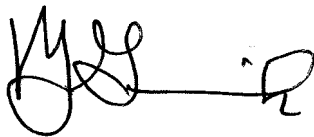
Among the issues on which the Board has commented that it believes require continued or additional attention are (1) the integration, design, and operation of elements of the waste management system;* (2) a better understanding of the waste-isolation characteristics and behavior of the natural components of the repository; (3) an improved understanding and a clear explanation of the likely conditions inside repository tunnels after repository closure; (4) other corrosion issues; (5) resolution of discrepancies between chlorine-36 studies; (6) improvements in the modeling of volcanic consequences, taking into account incompressible flow, waste mobilization, and interaction of magma with the waste package; and (7) work undertaken by the science and technology program.

Board Priorities in 2005

The Board will follow the DOE's progress in addressing the issues listed above and other issues during the coming year. In particular, the Board intends to review the DOE's technical and scientific work and analysis supporting total system performance assessment. The Board also will evaluate technical and scientific work and analysis undertaken by the DOE in responding to changes in the regulatory compliance period for a Yucca Mountain repository and will continue its review of the DOE's efforts to develop an integrated waste management system.

The Board looks forward to continuing its congressionally established role of providing to Congress and the Secretary an unbiased and independent evaluation of the DOE's technical and scientific activities related to the disposal, packaging, and transportation of the country's spent nuclear fuel and high-level radioactive waste.

Sincerely,

A handwritten signature in black ink, appearing to read 'B. John Garrick', with a horizontal line extending to the right.

B. John Garrick
Chairman

Enclosure

* The waste management system includes waste acceptance; packaging of the waste for transportation, disposal, or aging; transportation of the waste from reactor sites or defense facilities to the repository site; design and operation of the surface and underground facilities at the site; possible aging of the waste on the site; and emplacement of the waste in a repository.

Enclosure

Additional Details on Areas of Board Focus

Areas of Progress

- *Corrosion* – In late 2003, the Board sent letters and a technical basis report to the Department of Energy (DOE) stating the Board’s concern that the calcium chloride-rich environment identified by the DOE and used in its corrosion testing would lead to deliquescence-induced corrosion of the waste packages in repository tunnels during the thermal pulse. In response, the DOE presented data and analysis at the Board’s May 2004 meeting indicating that it is unlikely that dusts that accumulate on waste package surfaces during the preclosure period would contain significant amounts of calcium chloride or that significant amounts of calcium chloride would evolve on waste package surfaces during the thermal pulse. Consequently, the calcium chloride-rich environment selected for corrosion tests does not appear representative of the conditions that can be expected on waste package surfaces in a Yucca Mountain repository. If calcium chloride is not present, calcium chloride-rich brines will not form by deliquescence, and crevice corrosion due to the presence of such brines in the temperature range of roughly 140°C to 160°C will not occur. Thus, the Board concludes that localized corrosion of the waste package due to deliquescence of calcium chloride during the higher-temperature period of the thermal pulse is unlikely.
- *Ground-Motion Estimates* – The program has taken significant steps toward developing realistic estimates of ground motions. The Board encourages the DOE to continue these efforts using sound physical principles to limit the proposed estimates of very-low-probability earthquake ground motions. Of importance is that all currently planned work is continued and that short- and long-term seismic efforts are well integrated and subjected to external peer review.
- *Transportation Planning* – The Board commends the DOE on its effort in developing a systematic approach to transportation planning. Attempts to adopt such an approach were evident at the national transportation program level and within specific components of the planning effort (e.g., risk assessment of transportation security). This is the proper framework, within which more-detailed planning is expected to be performed.

Areas Requiring Attention

- *Integration of the Waste Management System* – The Board believes that waste handling and surface storage at Yucca Mountain should be viewed and analyzed as parts of an integrated waste management system that begins when waste is accepted for shipment at reactors and other sites and ends after placement of the waste in a repository. Because the many elements

of a waste management system are interdependent, integrated analyses are needed to understand the viability of the system, identify possible safety and operational concerns, and optimize the system. For example, the DOE should analyze ways to minimize the number of times that fuel assemblies are handled. The DOE also should analyze how aging of spent fuel in surface storage at Yucca Mountain would be used to achieve thermal goals as part of a clearly articulated thermal management strategy.

DOE presentations at the Board's October panel meeting did not demonstrate the degree of program integration needed to ensure that the transportation system will operate successfully. The DOE needs to plan for and be able to demonstrate harmonization of cask design, fleet acquisition, waste acceptance, operational practice, and other activities that must be carried out at reactor sites, during shipping, and at the repository.

- *Understanding the Behavior of the Natural Components of the Repository System* – Field and laboratory observations and analyses presented by the DOE and others suggest that the natural system may provide an effective barrier to migration of some radionuclides for substantial periods of time. The Board's May 3, 2004, letter to the DOE highlighted the value of enhancing the fundamental scientific and technical basis for estimates of the potential performance of the natural barriers. In that letter, the Board identified several key hydrogeologic features or processes that may significantly affect fluid flow and radionuclide transport and are presently not well understood or are constrained by limited or poor data, or both. Items identified in the letter included hydraulic properties of major block-bounding faults, secondary mineralization of radionuclides, matrix diffusion, and colloid-facilitated transport. Improved understanding and more-realistic representation of these parameters in performance predictions may substantially increase or in some cases decrease predicted periods of radioactive waste isolation; in any case, such efforts would enhance the overall technical credibility of the performance predictions.

The Board continues to believe that an integrated explanation is needed of how elements of the repository act as a system to isolate waste. Such an explanation should rest on a fundamental understanding of the system and on multiple lines of evidence. Multiple lines of evidence and argument can be used to supplement total system performance assessment (TSPA) and to evaluate the conceptual understanding of natural systems at the site, the models used to represent those concepts, and the scenarios predicted by the models.

- *Repository Tunnel Environments* – The extent to which the DOE has characterized accurately the likely waste package environments (i.e., temperature, relative humidity, and chemical species present) is unclear at this point. Accurate characterization of probable waste package environments and the corrosion response of the waste package alloy to those environments will continue to be a major focus of the Board's technical and scientific review.

In its November 2003 letter to the DOE, the Board indicated that it agrees with the DOE that boiling during the thermal pulse and capillarity during and following the thermal pulse would significantly reduce the seepage of water into repository drifts but that the pervasiveness of these barriers throughout repository tunnels is not assured. Because of persistent uncertainties related to the expected repository tunnel environments, the Board continues to question the pervasiveness of vaporization and capillary barriers.

- *Other Corrosion Issues* – Several corrosion issues that require additional analysis were discussed at the Board’s May 2004 meeting. First, the DOE raised the possibility that when temperatures in repository tunnels fall below boiling, localized corrosion could occur in concentrated sodium chloride solutions containing low concentrations of inhibitors. The Board believes that further investigation of the possibilities for localized corrosion at below-boiling temperatures is warranted and that such an investigation should focus on (1) possible mechanisms that might create environments that would facilitate localized corrosion and (2) the likelihood that such environments could exist. Second, the presence of ammonium ion and the implications of its presence for corrosion or other performance aspects need to be explained. Third, the Board believes that reviewing existing corrosion data would be worthwhile to determine whether they bound nitrate-containing environments that could reasonably be anticipated at Yucca Mountain.

The possibility of stress-corrosion cracking of the titanium drip shield was mentioned at the Board’s September 2004 meeting. The Board looks forward to receiving more information on the technical basis for the DOE’s conclusions that stress-corrosion cracks that completely penetrate the drip shield would be rare and that, if they did occur, would be narrow and plugged by mineral precipitates or overcome by capillary forces. We also recommend that the DOE determine the likelihood that conditions necessary for stress-corrosion cracking of the drip shield would occur at Yucca Mountain.

- *Chlorine-36 Studies* – Water collected in the east-west cross drift and the possible presence of bomb-pulse chlorine-36 at the repository horizon continue to raise questions about water flow inside Yucca Mountain. The DOE should resolve discrepancies that still exist between studies attempting to establish the implications of bomb-pulse chlorine-36.
- *Volcanic Consequences* – The Board’s recommendations related to upgrading igneous consequence models to take into account incompressible flow should be considered. Additional work is needed on the implications of the interaction of magma with waste packages.
- *Science and Technology Program* – The science and technology (S&T) program was established by the Office of Radioactive Waste Management in 2002. The purposes of the program are to increase fundamental understanding and to explore concepts that could improve the waste management system. Because the objectives of the S&T program are so important, the Board recommended to the DOE that the program be continued at or above its current level.

Board Priorities in 2005

- *Waste Management System* – The Board will continue evaluating the DOE’s efforts to develop a waste management system that includes (1) waste acceptance; (2) packaging of the waste for transportation, disposal, or aging; (3) transportation of the waste from reactor sites or defense facilities to the repository site; (4) design and operation of the surface and underground facilities at the site; (5) possible aging of the waste on the site; and

(6) emplacement of the waste in the repository.

- *TSPA* – The Board will review TSPA results that will be submitted as part of the DOE’s license application (TSPA-LA), technical and integration problems associated with TSPA and model-validation activities (as presented by the DOE at the Board’s September meeting), and how the DOE is addressing the problems.
- *Technical and Scientific Work Related to Changes in the Compliance Period* – The Board intends to review how the DOE’s technical and scientific activities are affected by the vacating of the 10,000-year regulatory compliance period. The Board will evaluate any new technical and scientific analysis undertaken by the DOE to address these changes.
- *Additional Issues* – The Board will continue evaluating progress made by the DOE in addressing the issues discussed in this letter and in previous Board letters to the DOE.