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

December 30, 2005

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

The Honorable Ted Stevens
President Pro Tempore
United States Senate
Washington, D.C. 20510

The Honorable Samuel W. Bodman
Secretary
U.S. Department of Energy
Washington, D.C. 20585

Dear Speaker Hastert, Senator Stevens, and Secretary Bodman:

The Nuclear Waste Technical Review Board was created by Congress in the Nuclear Waste Policy Amendments Act (NWPAA) of 1987 and charged with performing an ongoing and independent evaluation of the technical and scientific validity of the Department of Energy's (DOE) activities related to disposing of, packaging, and transporting high-level radioactive waste and spent nuclear fuel. The primary focus of the Board's evaluation is the DOE's efforts to develop a proposed repository for the permanent disposal of such waste at Yucca Mountain in Nevada. The NWPAA directs the Board to report its findings and recommendations at least twice a year to Congress and the Secretary of Energy. This is the Board's second report of 2005, submitted in accordance with provisions of the NWPAA of 1987, Public Law 100-203.

Throughout 2005, the Board has continued its review of the DOE program. Between March and October, small contingents of Board members and staff held several fact-finding meetings with the DOE, its contractors, and key stakeholders (e.g., representatives of the rail and trucking industries, the nuclear utilities, and logistics service providers). The fact-finding meetings enabled the Board to engage in focused discussions of important technical issues and to understand better the DOE's methods of scientific and engineering analysis of the Yucca Mountain site. Those meetings and a meeting of the full Board in November facilitated the Board's evaluation of current issues of importance to the DOE program and helped identify additional technical issues that will be the focus of the Board's evaluation in the next few years. Among the issues emphasized by the Board in 2005 was increased understanding of radionuclide mobilization, retention, retardation, and transport in an integrated repository system.

In the following paragraphs, the Board presents its views on the status of some important issues and outlines issues that it expects may continue to be of interest in the future. In organizing its comments, the Board refers to several "systems" and performance assessments. The *waste management system* consists of a number of elements, including accepting waste at utility or DOE defense-complex sites; handling, transporting, processing, and storing the waste; and emplacing the waste underground. The *engineered system* is the engineered components of a repository, such as the waste package and the drip shield. The *natural system* includes geologic barriers and natural processes, features, and events. Taken together, the engineered system and the natural system constitute the *repository system*. The performance of the systems is estimated through the use of mathematical *performance assessment* models and supporting evidence from field and laboratory tests. The assessment of the behavior and performance of one system or an element of a system may strongly depend on or affect the others. The Board believes that this interdependence should be taken into account in performance assessments and when changes to the program are proposed.

***Waste Management System***

This has been an eventful year for the Yucca Mountain program, during which important changes have been proposed for the waste management system that the DOE says are intended to emphasize safety and reliability and reduce the complexity of surface facilities and waste handling. The most notable change is the decision to evaluate the development of the transportation, aging, and disposal (TAD) canister system. The Board believes that this system has the potential to address concerns previously stated by the Board related to excessive fuel handling.[1] However, selecting the "right" canister(s) for the TAD system will depend on discussions and close cooperation between the DOE and nuclear utilities, because the utilities will be responsible for loading the TAD canisters at their power plants. To facilitate the integration of the new system, the Board recommends that the DOE determine first-hand the compatibility of possible TAD canister designs with the capabilities for storage, handling, and transportation options at each reactor site.

The success of the TAD canister system will depend on integration of the TAD concept into a waste management system that effectively balances preclosure safety and repository performance and that is based on a viable and clearly defined thermal-management strategy. The thermal-management strategy is a key element of the technical basis for acceptance, transportation, handling, and emplacement of waste. The Board believes that thermal criteria should be integrated into a consistent technically supported basis that should result in waste handling and facility operations that are safe, flexible, reliable, and simple. In addition, a key aspect of a thermal-management strategy should be enhancing understanding of postclosure conditions in repository tunnels to ensure that the conditions would not affect adversely the performance of the engineered and natural barriers. Because of the importance of the thermal-management strategy for the waste management and repository systems, the Board recommends that a group of outside experts review the strategy and its analytical support, as has been done with the DOE's total system performance assessment for license application (TSPA-LA).

[1] Board letter to Theodore Garrish; April 19, 2005.

The DOE has developed a total system model (TSM) that the Board believes has significant potential as a tool for understanding better the performance of the waste management system, and, perhaps, in preparing the preclosure safety analysis. However, it is very important to the success of the model that it incorporates the most up-to-date information (e.g., the availability of spent fuel and on-site waste handling equipment) and that the quality of all input data and assumptions is confirmed. The Board has asked the DOE for additional information so that it can more fully evaluate the capabilities and limitations of the TSM.

In the coming year, the Board expects to look closely at DOE efforts related to discussing the TAD system with utilities and determining by direct observation the compatibility of possible TAD designs with capabilities for storage, handling, and transportation at each reactor site. The Board also will evaluate information from the DOE on the capabilities and limitations of TSM and the validity of TSM input data and assumptions. In addition, the Board will continue its ongoing evaluation of the technical validity of DOE activities related to designing, integrating, and implementing a safe and reliable system for transporting spent nuclear fuel and HLW.

***Engineered System***

The DOE has proposed screening out deliquescence-based localized corrosion of the waste packages from its TSPA-LA. However, the Board continues to be concerned about the potential for localized corrosion in deliquescent brines formed at temperatures between 160ºC and 220ºC from airborne dust that will be deposited on the surface of the waste packages. The Board believes that information presented by the DOE at its November meeting supporting the screening out of deliquescence-based localized corrosion was not compelling, primarily because no data were presented for temperatures above 150°C, and the data showing stifling of the corrosion at lower temperatures may or may not be relevant. The Board expects to hold a corrosion workshop in the coming year to discuss these very important issues in more detail.

The Board is evaluating information provided by the DOE that addresses previous Board questions about the drip shields, including metals selected for drip-shield design, fabrication, and emplacement; possible deformation due to creep of the drip-shield material under load; and degradation of drip shields due to corrosion and environmental and mechanical effects. In addition, the Board will look at the DOE's response to questions that have been raised by the State of Nevada about difficulties associated with installing the drip shields remotely in confined spaces, such as repository tunnels.

Issues related to the engineered system that will be evaluated by the Board in the coming year include the effects of corrosion products from the stainless steel inside the waste packages, the effects of temperature on general corrosion rates, integration into performance estimates of information on waste package corrosion from studies undertaken by the DOE's Office of Science & Technology and International (OSTI), the analysis supporting the behavior of radionuclide release from the waste packages, the effects on the thermal strategy of using backfill in repository tunnels, and alternative ways to support repository tunnels.

***Natural System***

Properties of the natural system will affect the containment and transport of radionuclides and the effectiveness of the engineered barriers. At Yucca Mountain, many large-scale, long-term tests are about to be concluded that may shed light on estimates of the performance of the natural barriers at the site. The Board believes that much can be learned from post-test characterization, including a better understanding of some of the anomalies that have occurred and refinement in the current interpretation of test results. It is important that the DOE complete and fully assess the results of these tests. The Board also continues to support testing in the unsaturated and saturated zones at Yucca Mountain and at natural-analog sites (e.g., Peña Blanca in Mexico) to understand better the contribution of the natural system to repository performance.

During the last year, the Board has emphasized other issues of importance to increasing understanding of how the repository will behave after closure. For example, *thermal conductivity* of the rock at Yucca Mountain is of fundamental importance in predicting tunnel environments, especially thermohydrologic conditions that the waste packages will encounter. Obtaining additional data collected in repository rocks under predicted repository conditions could reduce uncertainty about postclosure tunnel environments and thus improve predictions of long-term repository performance. Another issue of importance to predicting repository performance is the nature of the *source term*,[2] including spent fuel oxidation, dissolution, and transport. In November, the DOE presented to the Board experimental data indicating that neptunium (Np) transport may not be significantly delayed by co-precipitation. The Board also found that the drip-test data presented by the DOE do not strongly support the assertion that Np solubility curves used in TSPA are conservative. The Board is pleased that this topic will be addressed by studies sponsored by the OSTI. Finally, inconsistencies in past DOE studies of chlorine-36 (Cl-36) in Yucca Mountain create questions about the technical basis of DOE model predictions of *water flow and radionuclide transport*. The Board has encouraged the DOE to determine the source of discrepancies among Cl-36 studies. Another issue related to water flow in the repository is the "multiscale" water flow model. The multiscale model provides the basis for predicting radionuclide migration in the natural system. The Board believes that the model should be reviewed by an independent panel of experts similar to the one used for evaluating TSPA-LA. In addition, the OSTI is in the process of providing enhanced technical bases and understanding for the behavior of water in the repository environment. The Board encourages continued work in this area.

The Board will continue to evaluate important factors related to the natural system, including potential evidence that flow in the unsaturated zone is buffered from climate changes at the surface and that fracture-matrix interaction in the unsaturated zone is greater than assumed in the DOE's TSPA. In addition, the Board would like to have more information on how data on possible reducing conditions in the groundwater at Yucca Mountain can be reconciled with presumed flow rates and directions in the area. The Board also will evaluate the DOE's estimates of matrix diffusion and of retardation and retention of radionuclide colloids in the alluvium.

[2] Types and amounts of radionuclides that are the source of a potential release from the repository.

***Repository Performance Assessment***

TSPA-LA is a tool used to evaluate whether releases from the proposed repository would comply with the regulatory standard. Using multiple conservatisms and a "cautious but reasonable" approach, the DOE believes that the TSPA-LA provides a conservative assessment of repository performance and associated uncertainties. However, the DOE does not appear to know the extent to which TSPA-LA is conservative overall. The Board believes that levels of conservatism associated with different components of TSPA-LA vary significantly and that TSPA-LA is, in general, unrealistic. The use of multiple conservatisms (and some non-conservatisms) may mask effects and obscure fundamental understanding of how the engineered and natural barriers would work together as an integrated system to isolate waste. As a result, important constituencies (i.e., policy-makers, the scientific community, and the public) are deprived of meaningful information on which to base their opinions and judgments. In the Board's view, the DOE's contention that conducting sensitivity analyses of TSPA-LA would enhance system understanding has limited validity, because the effects of parameter and model changes related to one component of the system or subsystem may be masked by assumptions about other components of the system or subsystem. The DOE needs to provide a basis for their contention about the robustness of sensitivity analyses.

The Board believes that in addition to and parallel with the compliance case, the DOE should develop a realistic analysis of repository performance based on assessments by project scientists of how the repository would behave. Such an analysis would be invaluable for fundamental understanding, for informing key constituencies, and for building confidence in the DOE's estimates of repository performance. It also may provide an indication of the margins or level of conservatism built into the TSPA-LA model, which the DOE is presently unable to address.

The Board will continue its evaluation of these and other important technical and scientific issues in the coming year. As mandated by Congress, we will continue to provide technical and scientific information to Congress and the Secretary of Energy related to safely disposing of, transporting, and packaging the country's spent nuclear fuel and high-level radioactive waste.

Sincerely,

{Signed by B. John Garrick}

B. John Garrick
Chairman