Statement of
B. John Garrick, Chairman
U.S. Nuclear Waste Technical Review Board
Before the
Committee on Energy and Natural Resources
United States Senate
May 16, 2006

Mr. Chairman and members of the Committee, good morning. My name is John Garrick. I am Chairman of the U.S. Nuclear Waste Technical Review Board. The 11 members of the Board are appointed by the President and serve on a part-time basis. Most of us have full-time occupations. In my case, I am a consultant specializing in the application of the risk sciences to complex technological systems in the space, defense, chemical, marine, and nuclear fields. I am pleased to represent the Board at this hearing on the status of the Yucca Mountain program.

As you know, Mr. Chairman, the Board was created by Congress in the 1987 amendments to the Nuclear Waste Policy Act and charged with performing an ongoing and independent evaluation of the technical and scientific validity of Department of Energy (DOE) activities related to disposing of, packaging, and transporting high-level radioactive waste and spent nuclear fuel. The Board began its work in 1989 and has continuously reviewed the technical and scientific validity of DOE activities since that time.

The Board's technical evaluation focuses on preclosure and postclosure issues, including (1) the operational, safety, and security performance of the proposed repository and (2) the overall performance of the integrated waste management system. The Board believes that a central part of its mandate is providing information on its technical evaluation to members of Congress who will make important decisions on the management and disposal of spent nuclear fuel and high-level radioactive waste. For that reason, the Board is especially pleased to participate today in this hearing on the status of the proposed repository at Yucca Mountain in Nevada.

Mr. Chairman, over the last 18 months or so, the Board held a series of meetings with the DOE that enabled the Board to engage in detailed technical discussions of methods of analysis used by the program. The Board will soon release a report to Congress and the Secretary of Energy that summarizes the Board's activities over the last year and that includes details of its evaluation of the DOE's technical and scientific work. In my testimony today, I will highlight some of the key issues discussed in that report and other issues that have emerged in the last few weeks.

Before I discuss in more detail the Board's technical evaluation of DOE activities related to Yucca Mountain, I want to make clear that, in general, the Board believes that the DOE has made meaningful progress over the last year, especially in obtaining information on the performance capability of the engineered barrier system and on the chemistry, magnitude, and rates of mountain-scale groundwater flow in the unsaturated and saturated zones under ambient temperature conditions. Using sophisticated simulation models, the DOE also has improved its ability to evaluate preclosure and postclosure performance as an integrated system. In addition, efforts have been made to reorganize the program, and a major proposal for implementing a canister-based system that can accommodate storage, transportation, and disposal of spent nuclear fuel has been proposed. As a result, the Board believes that additional evidence necessary for credibly evaluating the performance of the entire waste system can be developed. I will now discuss in more detail the status of some important technical issues.

Realistic Performance Assessment

Mr. Chairman, as you would expect, the DOE's efforts to prepare a license application have dominated its work for the last several years. The primary tool used by the DOE to evaluate the performance of the repository is total system performance assessment, or TSPA. TSPA is a comprehensive set of computer models that uses experience, available data, assumptions, and probabilities to estimate potential dose and compliance with the regulatory standard. Uncertainty is necessarily associated with these projections that are made for periods of up to one million years. To deal with uncertainty or gaps in understanding, the DOE often uses what it considers conservative assumptions about the features or processes being modeled. Examples of this are the ways that the DOE models the temperature dependence of generalized corrosion rates, sorption in the saturated zone, and the containment capability of some parts of the engineered barrier system.

However, because the DOE's assumptions are not always conservative, the overall degree of conservatism is hard to assess. Consequently, TSPA may not give a realistic picture of how a proposed repository would perform. The Board believes that carrying out realistic performance analyses, perhaps in parallel with efforts to develop a compliance case, could establish a "baseline" for measuring how conservative—or nonconservative—the DOE's repository performance estimates might be. Having this information would provide decision-makers, the scientific community, and affected parties with important and relevant information.

In addition, the Board believes that there is considerable uncertainty about the source term incorporated in TSPA. (The source term refers to the compositions, kinds, and amounts of radionuclides that make up the source of a potential release of radioactivity from the engineered barrier system to the host rock.) To increase confidence in performance estimates, the Board has suggested that the DOE focus on analyzing the source term and tracking the radionuclides most significant to dose (neptunium-237 and plutonium-242) through the engineered and natural systems. The DOE is trying to increase its understanding of the source term through work sponsored by its Science and Technology Program. The Board believes that this important work should continue.

The Engineered System

The outer barrier of the waste package is made of a corrosion-resistant material known as Alloy 22. Alloy 22 will not corrode significantly unless liquid water is present on the waste package surface. The higher the temperature at which liquid water is present, the greater the concern because metals corrode faster and are more susceptible to corrosion at higher temperatures. The DOE maintains that potential localized corrosion of Alloy 22 at elevated temperatures under aqueous conditions can be excluded from its TSPA calculations. In the Board's view, the technical basis for the exclusion is not compelling. The Board continues to believe that obtaining experimental data on localized corrosion should be a high priority, especially given the DOE’s current high-temperature repository design. In addition, future performance assessments should not exclude general corrosion at elevated temperatures when aqueous conditions are predicted to be present. The Board will hold a workshop in September at which issues related to localized corrosion will be discussed.

The Natural System

The natural geologic system at Yucca Mountain will play an important role as a barrier to radionuclide transport. Properties of the natural system will affect the speed of transport and the effectiveness of the engineered barriers. Over time, the DOE has continued to refine and update its model for flow and transport in the unsaturated zone. At this point, no evidence has been developed that calls into question the DOE's long-held view that flow in the unsaturated zone is dominated by fractures and faults. In addition, the Project's findings on the chemistry of water in the unsaturated and saturated zones appear broadly consistent with a large body of empirical data and experience. However, the Board continues to question the DOE's understanding of the unsaturated zone beneath the proposed repository in relation to retarding and retaining radionuclides. The Board believes that obtaining additional information on radionuclide transport is warranted, especially on secondary minerals and on colloid-facilitated radionuclide transport. Such information could be important for assessing repository performance. For example, if future investigations confirm that neptunium is captured in secondary mineral phases, estimates of the natural system's capability to isolate dose-contributing radionuclides could increase.

The Waste Management System

The Board believes that the DOE's new proposal for a canister-based system for transporting, aging, and disposing of (TAD) spent fuel holds promise as a way of minimizing the handling of bare spent-fuel assemblies and simplifying the design of surface facilities at Yucca Mountain. However, the success of such an approach depends on a number of factors, including close cooperation and coordination among the DOE, nuclear utilities, and cask vendors. The DOE also must consider the range of consequences associated with implementing the TAD concept for preclosure and postclosure performance. The DOE's evaluation of TAD should include a more complete set of scenarios for waste acceptance, waste transportation, repository operations, design of repository surface facilities, and waste emplacement in the repository.

The DOE has developed the Total System Model (TSM), which can be used as a tool for analyzing a variety of preclosure scenarios and the performance of the entire waste management system. The TSM can be used to examine system throughput and to identify possible choke points; it can assess the effects of delayed construction of a rail spur; and it can evaluate conditions that contribute to efficient operation of the surface facilities. For the TSM to be used most effectively, it should have the ability to represent "upset" conditions and to analyze all waste management components, including emplacement. The TSM also should be based on the most up-to-date information, and the assumptions underlying the model should be confirmed.

Because of funding constraints, much of the Project's anticipated work on establishing a transportation network has been deferred. Nonetheless, the Board believes that the Project should perform a comparative risk analysis of rail corridors that might be used for moving spent fuel and high-level radioactive waste to Yucca Mountain, and, once that analysis has been completed, should inform all interested and affected parties of what routes it prefers. The DOE also should develop a contingency plan for greater use of legal-weight and heavy-haul trucking.

Cross-Cutting Issues

An issue that permeates preclosure operations as well as postclosure repository performance is the DOE's strategy for managing the heat generated by radioactive decay. For example, postclosure thermal requirements create constraints on plans for preclosure operations and the design of surface facilities at Yucca Mountain. Moreover, implementation of TAD will have implications for the thermal management strategy that do not appear to have been fully considered. As mentioned earlier, after the repository is closed, above-boiling repository temperatures that will last for about 1,000 years (the so-called thermal pulse) will affect the performance of the engineered system, including the waste packages. In particular, the potential for localized corrosion to initiate during the thermal pulse has yet to be resolved. In general, the Board believes that the DOE should consider the systemwide implications of and strengthen the technical basis for its thermal-management strategy, which also will be important for licensing.

I have referred several times in my statement to one or another “system." The Board often uses this term to emphasize that all the elements involved in packaging, transporting, and disposing of spent nuclear fuel and high-level radioactive waste are connected, so the assessment of the behavior and performance of one element may strongly depend on or affect the behavior and performance of others. The Board believes that the DOE’s preclosure and postclosure plans for the repository should recognize and accommodate those interdependencies. That is the reason that, over the years, the Board has strongly recommended integration of program elements across the broad range of scientific and engineering activities. The Board believes that any program reorganization should reflect the need to facilitate this essential integration.

Finally, Mr. Chairman, the Board believes that the technical work I have just discussed is doable and will enhance confidence in estimates of the performance of the repository and the waste-management system. The Board thanks the Committee for inviting it to participate in this hearing and hopes that the information we have furnished today will be helpful in providing a technical context for important decisions that you will make on disposing of and managing spent nuclear fuel and high-level radioactive waste.

I will be pleased to respond to questions.

SUPPLEMENTARY INFORMATION ON THE U.S. NUCLEAR WASTE TECHNICAL REVIEW BOARD

About the Board

The U.S. Nuclear Waste Technical Review Board was established on December 22, 1987, in the Nuclear Waste Policy Amendments Act (NWPAA) as an independent agency in the executive branch of the federal government. The Board is charged with evaluating the technical and scientific validity of activities undertaken by the Secretary of Energy, including the following:

- site characterization
- activities related to packaging and transporting high-level radioactive waste and spent nuclear fuel.

The Board was given broad latitude to review activities undertaken by the Secretary of Energy in implementing the Nuclear Waste Policy Act. However, the Board was not given authority to require the DOE to implement Board recommendations.* The Board is required to report its findings and recommendations at least twice each year to Congress and the Secretary of Energy.

Board Members

The NWPAA authorized a Board of 11 members. All the members serve on a part-time basis; are eminent in a field of science or engineering, including environmental sciences; and are selected solely on the basis of distinguished professional service. The law stipulates that the Board shall represent a broad range of scientific and engineering disciplines relevant to nuclear waste management. Board members are appointed by the President from a list of candidates recommended by the National Academy of Sciences. To prevent gaps in the Board's comprehensive technical review, Board members whose terms have expired continue serving until they are reappointed or their replacements assume office. The first members were appointed to the Board on January 18, 1989. Current members were appointed by President George W. Bush.

The names and affiliations of the current 11 Board members are listed below.

- B. John Garrick, Ph.D., P.E., is Chairman of the Board. A founder of PLG, Inc., he retired from the firm in 1997 and is an executive consultant. His areas of expertise include applications of the risk sciences to complex technological systems in the space, defense, chemical, marine, and nuclear fields.

* Taken from *Legislative History of the Nuclear Waste Policy Amendments Act of 1987*; February 26, 1998.

- Mark D. Abkowitz, Ph.D., is professor of civil and environmental engineering and director of the Vanderbilt Center for Environmental Management studies at Vanderbilt University. His areas of expertise include transportation safety and security, systems analysis, all-hazards risk management, and applications of advanced information technologies.

- William Howard Arnold, Ph.D., P.E., a private consultant, retired from Louisiana Energy Services in 1996. He holds a doctorate in experimental physics and has special expertise in nuclear project management, organization, and operations.

- Thure E. Cerling, Ph.D., is Distinguished Professor of Geology and Geophysics and professor of biology at the University of Utah. His areas of expertise include terrestrial geochemistry and geochemistry processes.

- David J. Duquette, Ph.D., is department head and professor of materials engineering at Rensselaer Polytechnic Institute. His areas of expertise include the physical, chemical, and mechanical properties of metals and alloys.

- George M. Hornberger, Ph.D., is Ernest H. Ern Professor of Environmental Sciences in the Department of Environmental Sciences at the University of Virginia. His areas of expertise include catchment hydrology and hydrochemistry and transport of colloids in geologic media.

- Andrew C. Kadak, Ph.D., is Professor of the Practice in the Nuclear Science and Engineering Department at the Massachusetts Institute of Technology. His areas of expertise include nuclear engineering and the development of advanced reactors.

- Ronald M. Latanision, Ph.D., is emeritus professor of materials science and engineering at the Massachusetts Institute of Technology and a principal in Exponent, a science and engineering firm. His areas of expertise include materials processing and corrosion of metals and other materials in aqueous environments.

- Ali Mosleh, Ph. D., is Nicole J. Kim Professor of Engineering, director of the Reliability Engineering Program, and director of the Center for Risk and Reliability at the University of Maryland. His areas of expertise include methods for probabilistic risk analysis and reliability of complex systems.

- William M. Murphy, Ph. D., is associate professor in the Department of Geological and Environmental Sciences at California State University, Chico. His research focuses on geochemistry, including the interactions of nuclear wastes and geologic media.

- Henry Petroski, Ph.D., P.E., is Aleksandar S. Vesic Professor of Civil Engineering and professor of history at Duke University. His areas of expertise include the interrelationship between success and failure in engineering design. He also has a strong interest in invention and in the history of evolution of technology.