Addendum A

U.S. Nuclear Waste Technical Review Board Performance Evaluation Fiscal Year 2005

The U.S. Nuclear Waste Technical Review Board

The Nuclear Waste Policy Amendments Act of 1987 directed the U.S. Department of Energy (DOE) to characterize one site at Yucca Mountain in Nevada to determine its suitability as the location of a permanent repository for disposing of commercial spent nuclear fuel and defense high-level radioactive waste. The Act also established the U.S. Nuclear Waste Technical Review Board (Board) as an independent agency within the executive branch of the United States Government. The Act directs the Board to evaluate continually the technical and scientific validity of activities undertaken by the Secretary of Energy related to disposing of, transporting, and packaging the waste and to report its findings and recommendations to Congress and the Secretary of Energy at least twice yearly. The Board only can make recommendations; it cannot compel the DOE to comply. The Board strives to provide Congress and the Secretary of Energy with completely independent, credible, and timely technical and scientific program evaluations and recommendations achieved through peer review of the highest quality.

Board Performance Criteria and Method of Evaluation

The Board believes that measuring its effectiveness by directly correlating Board recommendations with improvements in the technical and scientific validity of DOE activities would be ideal. However, the Board cannot compel the DOE to comply with its recommendations. Consequently, a judgment about whether a specific recommendation had a positive outcome as defined above may be (1) subjective or (2) an imprecise indicator of Board performance because implementation of Board recommendations is outside the Board's direct control. Therefore, the Board has developed the following criteria to measure its annual performance in achieving individual performance goals.

1. Did the Board undertake the reviews, analyses, or other activities needed to evaluate the technical and scientific validity of the DOE activity identified in the performance goal?

2. Were the results of the Board's evaluation communicated in a timely, understandable, and appropriate way to Congress, the Secretary of Energy, the Office of Civilian Radioactive Waste Management (OCRWM), or the public?

If both measures are met in relation to a specific goal, the Board's performance in meeting that goal will be judged effective. If only one measure is met, the performance of the Board in achieving that goal will be judged minimally effective. Failing to meet both performance measures without sufficient and compelling explanation will result in a judgment that the Board has been ineffective in achieving that performance goal. If the goals are deferred or outdated, it will be noted in the evaluation.

The Board will use this evaluation of its own performance from fiscal year (FY) 2005, together with its assessment of current or potential key technical issues of concern related to the DOE program, to

develop its annual performance objectives and to inform spending allocations in its performance-based budget for subsequent years.

Performance Evaluation for FY 2005

The Board's performance goals for FY 2005 were developed to achieve the general goals and strategic objectives in the Board's strategic plan for fiscal years 2004-2009. The goals also were established in accordance with the Board's statutory mandate and reflect congressional action in 2002 authorizing the U.S. Department of Energy (DOE) to proceed with developing an application to be submitted to the U. S. Nuclear Regulatory Commission (NRC) for authorization to construct a repository at Yucca Mountain. The Board's performance goals reflect the continuity of the Board's ongoing technical and scientific evaluation and the Board's efforts to evaluate program activities, taking into account the interdependence of components of the repository system and the waste management system.

This evaluation will be submitted to the Office of Management and Budget (OMB), attached to the Board's budget request to Congress for FY 2007, included in the Board's summary report for 2005, and posted on the Board's Web site (www.nwtrb.gov). The reliability and completeness of the performance data used to evaluate the Board's performance relative to its annual performance goals are high and can be verified by accessing the referenced documents on the Board's Web site.

Strategy for Achieving Performance Goals

To evaluate DOE activities and achieve its performance goals, the Board engages in the following activities in any given year:

- Holding public meetings of the full Board and of Board panels.
- Reviewing the common DOE database, including scientific literature and laboratory and field data, contractor reports, analysis and model reports, and total system performance assessment (TSPA).
- Meeting with DOE contractor principal investigators on technical issues, observing ongoing tests and laboratory and field investigations, and visiting potential analog sites.
- Visiting nuclear waste disposal programs in other countries and attending national and international symposia and conferences.

In addition, in FY 2005, small contingents of Board members and staff held 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 concentrated discussions of important technical issues and to understand better how the DOE applies fundamental methods of analysis. Those meetings facilitated and enhanced 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 of DOE activities in coming years. In the following evaluation of the Board's performance for FY 2005, the meetings are referenced by date and the topics discussed.

For this evaluation, the Board's performance goals for FY 2005 have been organized and numbered to correlate with appropriate strategic objectives in the Board's strategic plan for FY 2004-2009.

FY 2005 Board Performance Goals and Evaluation

1. The Natural System

1.1.1. Review the technical activities and agenda of the DOE's science and technology program.

- *Evaluation of 1.1.1:* ***Effective.*** *Explanation: During FY 2005, the Board engaged in several fact-finding meetings at which activities of the Office of Science & Technology and International (OSTI) were discussed. In its letter dated November 30, 2004, to OCRWM director, Dr Margaret Chu, the Board commented on the importance of the science and technology program. In its December 30,*

2004, letter report to Congress and the Secretary of Energy, the Board again commented on the importance of the science and technology effort.

1.1.2. Monitor the results of DOE flow-and-transport studies to obtain information on the potential performance of the saturated zone (SZ) as a natural barrier in the repository system.

- *Evaluation of 1.1.2:* ***Effective.*** *Explanation: The Board held a fact-finding meeting on SZ flow and transport on September 7-8, 2005. The DOE's work related to understanding SZ flow and transport was discussed in some detail at the meeting. The Board's December 2004 report to Congress and the Secretary described studies and analyses under way indicating that the natural system might be an effective barrier against radionuclide migration and identifying a better understanding of the waste-isolation characteristics and behavior of the natural system as an area requiring more attention.*

1.1.3. Review DOE efforts to confirm estimates of natural-system performance, including tests of models and assumptions, and the pursuit of independent lines of evidence.

- *Evaluation of 1.1.3:* ***Effective.*** *Explanation: The Board commented on DOE efforts to increase fundamental understanding of the Yucca Mountain site in its November 2004 letter to Dr. Chu. The Board's December 2004 report to Congress and the Secretary described studies and analyses under way indicating that the natural system might be an effective barrier against radionuclide migration and identifying a better understanding of the waste-isolation characteristics and behavior of the natural system as an area requiring more attention. In the same letter report, the Board stated that estimates of the performance of the natural barriers should be based on multiple lines of evidence. The Board held two fact-finding meetings during FY 2005, at which the SZ and the unsaturated zone (UZ) were discussed in detail.*

1.2.1. Review DOE efforts to resolve questions related to possible seismic events and igneous consequences.

- *Evaluation of 1.2.1:* ***Effective.*** *Explanation: The Board commented on the DOE's progress in developing realistic ground-motion estimates in its November 2004 letter to Dr. Chu and noted that OSTI was undertaking work in this area. The Board included its comments on realistic ground-motion estimates in its December 2004 letter report to Congress and the Secretary. In the same report, the Board noted the completion of an aeromagnetic survey that could shed light on igneous activity at Yucca Mountain and commented on the need to improve modeling of volcanic consequences.*

1.3.1. Evaluate geologic, hydrologic, and geochemical information obtained from the enhanced characterization of the repository block (ECRB) at Yucca Mountain.

- *Evaluation of 1.3.1:* ***Effective.*** *Explanation: The Board commented on the importance of maintaining access to the ECRB in its November 2004 letter to Dr. Chu. The Board held a fact-finding meeting on June 27-28, 2005, at which issues relevant to testing in the ECRB were discussed. The Board will comment on the need to complete studies in the ECRB in its December 2005 report to Congress and the Secretary.*

1.3.2. Evaluate data from the drift-scale heater test.

- *Evaluation of 1.3.2:* ***Effective.*** *Explanation: The Board commented on the importance of completing the drift-scale heater test in its November 2004 letter to Dr. Chu. The Board held a fact-finding meeting on the UZ in June 2005 at which issues relevant to the drift-scale heater test were discussed. The Board will comment on the need to complete the drift-scale test in its December 2005 report to Congress and the Secretary.*

1.3.3. Review plans and work carried out on possible analogs for the natural components of the repository system.

- *Evaluation of 1.3.3:* ***Minimally effective/ deferred.*** *Explanation: The DOE did not report on its activities in this area during FY 2005. The Board will comment on the need to continue testing at the Peña Blanca analog site in its December 2005 letter report to Congress and the Secretary.*

1.3.4. Recommend additional work needed to address uncertainties, paying particular attention to estimates of the rate and distribution of water seepage into the repository under proposed repository design conditions.

- *Evaluation of 1.3.4:* ***Effective.*** *Explanation: The Board discussed with the OCRWM ways to reduce technical and scientific uncertainty and make performance estimates more realistic at several fact-finding meetings held in 2005. The Board commented on the need for a clear explanation and understanding of repository conditions after closure in its December 2004 letter report to Congress and the Secretary. In the same report, the Board cited the need to address uncertainties related to the pervasiveness of capillary and thermal barriers, which will affect seepage into repository tunnels. The Board commented on the DOE's climate studies using opal dating in its April 19, 2005, letter to OCRWM director, Theodore Garrish.*

1.4.1. Evaluate tunnel-stability studies undertaken by the DOE.

- *Evaluation of 1.4.1:* ***Minimally Effective/ deferred.*** *Explanation: The Board discussed tunnel stability at its fact-finding meeting with the DOE on surface/subsurface facility design and operations held on September 19-20, 2005. Plans are under way for a small fact-finding meeting with the OCRWM in early 2006 to discuss research results from OSTI work.*

1.5.1. Review DOE efforts to integrate results of scientific studies on the behavior of the natural system into repository designs.

- *Evaluation of 1.5.1:* ***Effective.*** *Explanation: The Board discussed these issues with the OCRWM at a fact-finding meeting on surface/subsurface facility design on Sept 19-20, 2005. The Board commented on the need for such integration in its November 2004 letter to Dr. Chu. Integration of TSPA and repository design was discussed at a meeting of the full Board held on February 9-10, 2005.*

2. The Engineered System

2.1.1. Monitor the DOE's performance allocation studies.

- *Evaluation of 2.1.1:* ***Outdated goal.*** *Explanation: No such DOE studies were performed in FY 2005 or are expected. This goal will be eliminated in FY 2006.*

2.2.1. Review thermal testing and rock stability testing related to potential conditions in repository tunnels.

- *Evaluation of 2.2.1:* ***Effective.*** *Explanation: The DOE's thermal management strategy was discussed at a meeting of the full Board in February 2004. The Board held fact-finding meetings with the OCRWM on thermal management on September 20-21, 2005, and on surface/subsurface facility design on September 19-20, 2005, at which these issues were discussed.*

2.2.2. Evaluate data from studies of the effects of corrosion and the waste package environment on the predicted performance of materials being proposed for engineered barriers.

- *Evaluation of 2.2.2:* ***Effective.*** *Explanation: Several Board members participated in three fact-finding meetings with the OCRWM at which these issues were discussed. The Board commented on the corrosion resistance of Alloy-22 in magmas and the potential for stress-corrosion cracking in its November 2004 letter to Dr. Chu. In its December 2004 letter report to Congress and the Secretary, the Board noted that a major issue involving deliquescence-induced localized corrosion had been addressed by the DOE. In the same report, the Board raised several other corro-*

sion issues that require continued attention, including the presence of ammonium ion in repository tunnels and potential stress-corrosion cracking of the drip shield.

2.3.1. Review the progress and results of materials testing being conducted to address uncertainties about waste package performance.

- *Evaluation of 2.3.1:* ***Effective.*** *Explanation: See evaluation of 2.2.2.*

2.3.2. Evaluate DOE efforts in identifying natural and engineered analogs for corrosion processes.

- *Evaluation of 2.3.2:* ***Deferred.*** *Explanation: The DOE did not engage in such activities during FY 2005.*

2.4.1. Monitor the DOE's development of analytical tools for assessing the differences between repository designs.

- *Evaluation of 2.4.1:* ***Effective.*** *Explanation: At the Board's February 2004 meeting, the DOE presented information related to the integration of TSPA results into repository design efforts. Several members of the Board participated in a September 2005 fact-finding meeting with the DOE on surface and subsurface facility design at which these issues were discussed.*

2.4.2. Evaluate the accuracy and completeness of the technical bases for repository and waste package designs and the extent to which the DOE is using the technical bases for modifying repository and waste package designs.

- *Evaluation of 2.4.2:* ***Effective.*** *Explanation: At the Board's February 2004 meeting, the DOE presented information related to the integration of TSPA results with repository design efforts. Several members of the Board participated in a September 2005 fact-finding meeting on surface and subsurface facility design at which these issues were discussed. In its November 2004 letter to Dr. Chu, the Board commented on the need to analyze engineering design using TSPA.*

2.4.3. Evaluate the integration of the subsurface design and layout with thermal management and preclosure facility operations.

- *Evaluation of 2.4.3:* ***Effective.*** *Explanation: See evaluation of 2.4.2.*

2.5.1. Assess the integration of scientific studies into engineering designs for the repository and the waste package.

- *Evaluation of 2.5.1:* ***Effective.*** *Explanation: Several members of the Board participated in a September 2005 fact-finding meeting with the OCRWM on surface and subsurface facility design at which these issues were discussed. The Board commented on the need to analyze and integrate engineering design using TSPA in its November 2004 letter to Dr. Chu.*

3. Repository System Performance and Integration

3.1.1. Identify which technical and scientific activities are on the critical path to reconciling uncertainties related to DOE performance estimates.

- *Evaluation of 3.1.1:* ***Effective.*** *Explanation: During 2005, Board members participated in fact-finding meetings with the DOE designed to provide detailed information on technical and scientific issues currently important to the DOE repository program. The Board's December 2004 letter report to Congress and the Secretary provided an overview of the Board's views on areas of progress and issues requiring additional attention.*

3.1.2. Determine the strengths and weaknesses of TSPA.

- *Evaluation of 3.1.2:* ***Effective.*** *Explanation: Several Board members participated in a fact-finding meeting with the OCRWM on TSPA in August 2005 at which these issues were discussed at length. The Board commented on issues related to integration and model validation in its November 2004 letter to Dr. Chu. The Board commented further on these issues in its December 2004 report to*

Congress and the Secretary. In its April 2005 letter to Mr. Garrish, the Board noted that TSPA will need to address relevant hydrologic processes that may be significant beyond 10,000 years and that technical and scientific elements of TSPA might change if the standard is modified.

3.1.3. Evaluate the DOE's treatment of seismic and volcanism issues in TSPA.

- *Evaluation of 3.1.3:* ***Effective.*** *Explanation: Several Board members participated in a fact-finding meeting with the DOE on TSPA in August 2005 at which these issues were discussed. In its November 2004 letter to Dr. Chu, the Board pointed out that engineering design and operations should be analyzed using TSPA to determine the potential significance of changes on the overall repository system. The Board used as an example that if the repository is modified to mitigate the effects of igneous activity, the modifications should be evaluated for their effects on repository performance. The Board also commented on the DOE's progress in making its ground-motion estimates more realistic. The same issues were raised in the Board's December 2004 letter report to Congress and the Secretary.*

3.2.1. Evaluate the DOE's quantification of uncertainties and conservatisms used in TSPA.

- *Evaluation of 3.2.1:* ***Minimally Effective.*** *Explanation: Several Board members participated in a fact-finding meeting with the DOE on TSPA in August 2005 at which these issues were discussed.*

3.2.2. Review new data and updates of TSPA models, and identify models and data that should be updated.

- *Evaluation of 3.2.2:* ***Effective.*** *Explanation: Several Board members participated in a fact-finding meeting with the DOE on TSPA in August 2005 at which these issues were discussed. In its April 2005 letter to Mr. Garrish, the Board noted that TSPA will need to address relevant hydrologic processes that may be significant beyond 10,000 years and that technical and scientific elements of TSPA might change if the standard is modified.*

3.3.1. Evaluate the DOE's efforts to create a transparent and traceable TSPA.

- *Evaluation of 3.3.1:* ***Effective.*** *Explanation: Several Board members participated in a fact-finding meeting on TSPA in August 2005 at which these issues were discussed. The Board will comment in its year-end report in December 2005 that the DOE should prepare a parallel analysis that can be used by policy-makers, the public, and the technical and scientific community to understand how the natural and engineered components of a repository would work together to isolate waste and to gauge the degree of conservatism of TSPA assumptions and estimates.*

3.3.2. Evaluate the DOE's efforts to develop simplified models of repository performance.

- *Evaluation of 3.3.2:* ***Effective.*** *Explanation: See Evaluation of 3.3.1.*

3.3.3. Evaluate the DOE's efforts to identify analogs for performance estimates of the overall repository system.

- *Evaluation of 3.3.3:* ***Deferred.*** *Explanation: The DOE did not present any information to the Board on this topic in FY 2005.*

3.4.1. Evaluate the DOE's efforts to analyze the contribution of the different engineered and natural barriers to waste isolation.

- *Evaluation of 3.4.1****: Effective.*** *Explanation: In its December 2004 letter report to Congress and the Secretary, the Board encouraged the DOE to continue studies that will lead to a better understanding of the contribution of the natural system. The Board will comment in its year-end report in 2005 that the DOE should prepare a parallel analysis that can be used by policy-makers, the public, and the technical and scientific community to understand how the natural and engineered components of a repository would*

work together to isolate waste and to gauge the degree of conservatism of TSPA assumptions and estimates.

3.5.1. Evaluate technical aspects of value engineering and performance-related trade-off studies, including criteria, weighting factors and decision methodologies for such studies and how technical uncertainties are taken into account.

- *Evaluation of 3.5.1:* ***Minimally effective.*** *Explanation: In September 2005, several Board members participated in a fact-finding meeting with the DOE on surface and subsurface facility design at which these issues were discussed. This performance goal will be modified in FY 2006.*

3.6.1. Recommend additional measures for strengthening the DOE's repository safety case.

- *Evaluation of 3.6.1:* ***Effective.*** *Explanation: In its April 2005 letter to Mr. Garrish, the Board stated that program integration is of continuing Board interest and could affect the DOE's safety case. The Board will comment in its year-end report in December 2005 that the DOE should prepare a parallel analysis that can be used by policy-makers, the public, and the technical and scientific community to understand how the natural and engineered components of a repository would work together to isolate waste and to gauge the degree of conservatism of TSPA assumptions and estimates.*

3.7.1. Evaluate DOE efforts to develop a feedback loop among performance-confirmation activities and TSPA models and data.

- *Evaluation of 3.7.1:* ***Effective.*** *Explanation: The DOE updated the Board on its performance-confirmation (PC) plans at the Board's February 2004 meeting. In the Board's April 2005 letter to Mr. Garrish, the Board observed that many activities identified to be undertaken as part of PC can be used for validating modeling assumptions that form the basis of TSPA. The Board noted that rather than being integrated, PC is operating independently of TSPA and of the ongoing work on repository design.*

3.7.2. Monitor the DOE's proposed performance confirmation plans to help ensure that uncertainties identified as part of the site recommendation process are addressed.

- *Evaluation of 3.7.2:* ***Effective.*** *Explanation: See evaluation of 3.7.1.*

4. The Waste Management System

4.1.1. Evaluate the operation of the entire repository facility, including the surface and subsurface components.

- *Evaluation of 4.1.1****: Effective.*** *Explanation: Several Board members participated in a fact-finding meeting with the DOE in September 2005 on surface and subsurface facility design and operations at which these issues were discussed in detail. In a November 2004 letter to Dr. Chu, the Board discussed integration of the total waste management system. The Board commented on integration of the waste management system in its December 2004 letter report to Congress and the Secretary, indicating that planning and design of an integrated waste management system would remain a top priority for the Board. The DOE presented an overview of waste management-system integration at the Board's February 2005 meeting. The Board commented again on these issues in its April 2005 letter to Mr. Garrish.*

4.1.2. Monitor the identification of research needs to support improved understanding of the interaction of components of the waste management system.

- *Evaluation of 4.1.2:* ***Effective.*** *Explanation: See evaluation of 4.1.1.*

4.1.3. Review the technical and scientific basis of the DOE's analyses of component interactions under various scenarios, including the degree of integration and redundancy across functional components over time.

- *Evaluation of 4.1.3:* ***Effective.*** *Explanation: See evaluation of 4.1.1.*

4.1.4. Evaluate the effects of reduced receiving capacity at the repository surface facility on the nationwide transportation system.

- *Evaluation of 4.1.4:* ***Effective.*** *Explanation: See evaluation of 4.1.1.*

4.1.5. Review criteria for waste acceptance for storage to ensure that accepted material has been suitably characterized for subsequent disposal.

- *Evaluation of 4.1.5:* ***Minimally effective/ deferred.*** *Explanation: Some discussion of these issues took place at a fact-finding meeting with stakeholders in October 2005. The Board will review whatever activities the DOE undertakes in this area in FY 2006.*

4.2.1. Monitor the DOE's efforts to implement Section 180(c) of the NWPA.

- *Evaluation of 4.2.1:* ***Effective.*** *Explanation: The Board's Panel on the Waste Management System held a meeting in October 2004 at which the DOE's development of Section 180(c) programs was discussed, including reactions to the DOE efforts by state and regional stakeholders. In a follow-up letter to Dr. Chu, the Board observed that emergency planning through the 180(c) program appeared to be based on funding formulas and not enough on ensuring that adequate emergency response capacity exists along all selected routes. The issue was raised again at a fact-finding meeting with stakeholders in October 2005.*

4.3.1. Monitor the DOE's progress in developing and implementing a transportation plan for shipping spent nuclear fuel and high-level radioactive waste to a Yucca Mountain repository.

- *Evaluation of 4.3.1:* ***Effective.*** *Explanation: The Board's panel on the Waste Management System met with the DOE and stakeholders in October 2004. The meeting agenda was devoted entirely to this topic. The Board sent a letter to Dr. Chu in December 2004 following up on issues identified at the October panel meeting. Some issues discussed in the letter included transportation planning—the Board recommended a systematic approach; security and emergency response planning; transportation risk assessment—the Board suggested a more risk-based approach; route selection; and program integration. The Board's December 2004 letter to Congress and the Secretary acknowledged transportation as an area where the DOE had made progress. Development of the waste management system was identified as a top priority for future Board review. In February 2005, the Board held a panel meeting on transportation—specifically, the Nevada branch line—in Caliente, Nevada. The Board sent a letter to Mr. Garrish on these subjects in April 2004.*

4.3.2. Review DOE efforts to develop criteria for transportation mode and routing decisions.

- *Evaluation of 4.3.2:* ***Effective.*** *Explanation: This topic was discussed at the Board's October 2004 panel meeting and in the December 2004 follow-up letter to the DOE. The Board indicated that it was advisable to involve state regional and tribal groups in developing the criteria. The Board noted that of particular importance was that technical issues are identified and that sound methods for addressing them are developed and applied.*

4.3.3. Evaluate logistics capabilities of the transportation system.

- *Evaluation of 4.3.3:* ***Effective.*** *Explanation: In the Board's April 2005 letter to the DOE, the total system model was mentioned as having potential for planning and integrating the waste management system. In its December 2004 letter, the Board suggested that the DOE work with utilities in designing the waste management system. This topic was discussed at a fact-finding meeting with transportation service providers in October 2005. In the Board's December 2005 letter to Congress and the Secretary, the Board suggested that the DOE should deter-*

mine first-hand the logistics capabilities at the reactor sites.

4.3.4. Monitor progress in implementing new technologies for improving transportation safety for spent nuclear fuel.

- *Evaluation of 4.3.4:* ***Effective.*** *Explanation: In the Board's April 2005 letter to the DOE, the total system model was mentioned as having potential for planning and integrating the waste management system. This topic also was discussed at a fact-finding meeting with transportation service providers in October 2005.*

4.3.5. Evaluate the DOE's plans for enhancing safety capabilities along transportation corridors, and review the DOE's planning and coordination activities (e.g., route selection), accident prevention activities (e.g., improved inspections and enforcement), and emergency response activities.

- *Evaluation of 4.3.5.:* ***Effective.*** *Explanation: See evaluation of 4.3.4.*

Addendum B

Supplementary Information On The U.S. Nuclear Waste Technical Review 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, and
- 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.*

Board Members

The NWPAA authorized a Board of 11 members who 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 10 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 a private consultant. His areas of expertise include probabilistic risk assessment and application of the risk sciences to technology-based industries.
- Mark Abkowitz, Ph.D., is a professor in the Department of Civil & Environmental Engineering and director of the Vanderbilt Center for Environmental Management studies at Vanderbilt University. His areas of expertise include risk management, transportation of hazardous materials, emergency preparedness, and applications of advanced information technology.
- 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 development.
- Thure Cerling, Ph.D., is a professor in the Department of Geology and Geophysics at the University of Utah. His areas of expertise include terrestrial geochemistry.

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

- David Duquette, Ph.D., is professor and head of the Department of Materials Science and Engineering at Rensselaer Polytechnic Institute in New York. 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 a Professor of the Practice in the Nuclear Engineering Department of the Massachusetts Institute of Technology. His areas of expertise include nuclear engineering and the development of advanced reactors.

- Ron Latanision, Ph.D., is a professor at the Massachusetts Institute of Technology with joint appointments in the Department of Materials Science and Engineering and the Department of Nuclear Engineering. His areas of expertise include materials processing and corrosion of metals and other materials in aqueous environments.

- Ali Mosleh, Ph.D., is professor of reliability engineering at the University of Maryland. His areas of expertise include risk and safety assessment reliability analysis and decision analysis.

- Henry R. Petroski, Ph.D., P.E., is professor of civil engineering and professor of history at Duke University. His areas of expertise include failure analysis and design theory.

Board Staff

The NWPAA limits the Board's professional staff to 10 positions. An additional 5 full-time employees provide administrative support to Board members and the professional staff. Because of the comprehensive nature of the program, the diversity of Board member experience and expertise, and the part-time availability of Board members, the small, highly qualified staff is employed to its full capacity in supporting the Board's review of the DOE program. The Board's offices are in Arlington, Virginia.

Board Reporting Requirements

As required under the NWPAA, the Board reports to the U.S. Congress and the Secretary of Energy at least two times each year. The reports include Board recommendations related to improving the technical and scientific validity of activities undertaken by the Secretary of Energy under the civilian radioactive waste management program. The DOE's written responses to Board recommendations are published in the Board's annual summary reports.

Board Activities

The Board and its panels sponsor meetings and technical exchanges with program participants and interested parties, including representatives of the DOE and its contractors, the U.S. Nuclear Regulatory Commission, the U.S. Environmental Protection Agency, the U.S. Geological Survey, the U.S. Department of Transportation, the State of Nevada, affected units of local governments, Native American tribes, nuclear utilities, environmental groups, state utility regulators, and members of the public. Board members and staff attend relevant technical conferences, meetings, symposia, and workshops. They participate in field trips and occasionally visit foreign programs to gain insights from the experience of other countries' repository development efforts.

Board and panel meetings are open to the public and are announced in the Federal Register four to six weeks before each meeting. To facilitate access for program participants and the public, the Board holds the majority of its meetings in the State of Nevada, and time is set aside for

public comment at each meeting. Transcripts of Board and panel meetings and all Board reports, correspondence, and congressional testimony are available to the public via telephone or written request or can be obtained from the Board's Web site: **www.nwtrb.gov.**