

U.S. Nuclear Waste Technical Review Board

Fiscal Year (FY) 2007

Budget Request Submittal

**Including Performance Evaluation for FY 2005
and Supplementary Information about the Board**

Summary And Highlights

This is the U.S. Nuclear Waste Technical Review Board's performance-based budget request for fiscal year (FY) 2007. The request will support the Board efforts to achieve its performance goals for the year. The performance goals are listed in the budget document and have been established in accordance with the Board's congressional mandate: To conduct an independent evaluation of the technical and scientific validity of U.S. Department of Energy (DOE) activities related to disposing of commercial spent nuclear fuel and defense high-level radioactive waste. These activities include evaluating the proposed Yucca Mountain repository site and packaging and transporting the waste. The Board's ongoing peer review is vital to the credibility of the DOE's technical and scientific activities.

In 2002, Congress approved the President's recommendation of Yucca Mountain and authorized the DOE to proceed with the preparation of an application that will be submitted to the Nuclear Regulatory Commission (NRC) for a license to construct a repository at Yucca Mountain. Throughout this process, the Board has evaluated the technical and scientific validity of DOE work and has reported its findings to Congress and the Secretary of Energy.

The Board's performance goals for fiscal year 2007 have been updated to reflect expected DOE activities during that period. For example, the Board will review DOE activities related to increasing understanding of the natural system, developing a radionuclide risk profile derived from TSPA, analyzing the implications of DOE's plans for a transportation, aging, and disposal canister system, and assessing issues relevant to thermal loading and waste-package lifetime. The Board also will review DOE activities related to planning and implementing a waste management system and designing, planning, and developing repository surface facilities. The Board is requesting **\$3,670,000** to support these activities in FY 2007.

U.S. Nuclear Waste Technical Review Board

Salaries and Expenses

(Including Transfer of Funds)

For necessary expenses of the Nuclear Waste Technical Review Board, as authorized by Public Law 100-203, section 5051, \$3,670,000, to be transferred from the Nuclear Waste Fund and to remain available until expended.

(2006 Energy and Water Development Appropriations Act, P.L. 109-103)

Board Budget Request for FY 2007

Background

Approximately 2,000 metric tons of spent nuclear fuel are produced each year by nuclear reactors and stored at more than 70 sites nationwide. By the time the presently operating reactors reach the end of their scheduled 40-year lifetimes (sometime in the 2030's), approximately 87,000 metric tons of spent fuel will have been produced. (This estimate does not include spent nuclear fuel from plants that may be granted license renewals by the NRC.) In addition, high-level radioactive waste (HLW) from defense activities has been stored at numerous federal facilities throughout the country. Disposal of the spent nuclear fuel and HLW in a deep geologic repository is the primary approach being pursued by the United States and other countries.

In early 2002, the Secretary of Energy recommended approval of the Yucca Mountain site to the President. The President then recommended the site to Congress. The State of Nevada later disapproved the recommendation. Both the U.S. House of Representatives and the U.S. Senate went on to approve the site recommendation. Since that time, the DOE has focused on preparing an application to be submitted to the NRC for authorization to construct a repository at the Yucca Mountain site. Throughout this process, the Board has evaluated the technical basis of the DOE's work and communicated Board views to Congress and the Secretary of Energy in letters, reports, and congressional testimony.

The Board's Continuing Role

The Board was established by Congress in the Nuclear Waste Policy Amendments Act of 1987 (NWPAA). The Board is charged with evaluating the technical and scientific validity of activities undertaken by the Secretary of Energy, including site-characterization activities and activities related to the packaging and transportation of high-level radioactive waste and spent nuclear fuel.¹ Board technical and scientific findings and recommendations are included in reports that are submitted at least twice each year to Congress and the Secretary. In creating the Board, Congress realized that an ongoing independent and expert evaluation of the technical and scientific validity of the DOE's site-evaluation and other waste-management activities would be crucial to acceptance by the public and the scientific community of any approach for disposing of spent nuclear fuel and high-level radioactive waste.

¹ 42 U.S.C. 10263

The Board's Funding Requirement for FY 2007: \$3,670,000

The Board's budget request of \$3,670,000 for FY 2007 represents the funding needed to accomplish the Board's performance goals for the year. During FY 2007, the Board intends to continue its evaluation of the technical and scientific validity of DOE activities, including those related to increasing understanding of the natural system, developing a radionuclide risk profile derived from TSPA, analyzing tradeoffs between pre- and post-closure risks, assessing issues relevant to thermal loading and waste-package lifetime, and evaluating the implications of plans for a transportation, aging, and disposal canister system. The Board also will review DOE activities related to planning and implementing a waste management system and designing, planning, and developing repository surface facilities. The amount requested will support the work of the Board members who will conduct the comprehensive review described above, enable the Board to comply with extensive federal security requirements related to the Board's information systems, and allow the Board to undertake a financial audit in accordance with the Accountability of Tax Dollars Act (ATDA).

Performance-Based Budget for FY 2007

The nation's goals related to the disposal of spent nuclear fuel and high-level radioactive wastes were set forth by Congress in the NWPAA. The goals are to develop a deep geologic repository or repositories for disposing of high-level radioactive waste and spent nuclear fuel at a suitable site or sites and to establish a program of research, development, and demonstration for the disposal of such waste.

The NWPAA limited repository-development activities to a single site at Yucca Mountain in Nevada. The NWPAA also established the Board and charged it with evaluating the technical and scientific validity of the Secretary of Energy's activities associated with implementing the NWPAA. Such activities include characterizing the Yucca Mountain site and packaging and transporting spent nuclear fuel and high-level radioactive waste.

The Board's general goals and strategic objectives are set forward in its strategic plan for FY 2004-2009. They have been established in accordance with the Board's statutory mandate and with congressional action in 2002 authorizing the DOE to proceed with the development of an application to be submitted to the NRC for authorization to construct a repository at Yucca Mountain. The Board's performance goals for FY 2007 have been established in accordance with its general goals and objectives. The Board's performance-based budget for FY 2007 has been developed to enable the Board to meet its performance goals for the year.

The Board will accomplish its goals by doing the following:

- Holding up to three public meetings with the DOE and DOE contractor personnel involving the full Board and holding meetings of the Board panels, as needed.
- When appropriate, holding fact-finding sessions involving small groups of Board members who will focus in-depth on specific technical topics.

- Reviewing critical documents provided by the DOE and its contractors, including total system performance assessment (TSPA), preclosure safety analyses (PCSA), contractor reports, analysis and modeling reports (AMR), and design drawings and specifications.
- When appropriate, visiting and observing ongoing investigations, including those conducted at the national laboratories or potential analog sites.
- Visiting programs in other countries and attending national and international symposia and conferences.

The Board’s performance goals for FY 2007, which are described below, are divided into four topical areas that correlate with the purviews of the Board’s panels. The numbering system has been simplified and performance goals have been updated from previous years to reflect current activities. Amounts have been preliminarily allocated to each set of performance goals for FY 2007.

Performance Goals for FY 2007

1. *Performance Goals Related to the Natural System*

(Dollars in Thousands)		
FY 05	FY 06	FY 07
839	893	917

- 1.1. Review DOE activities related to natural-system performance, including tests of models and assumptions, and the pursuit of independent lines of evidence.
- 1.2. Monitor the results of flow-and-transport studies to obtain information on the potential performance of the saturated zone as a natural barrier in the repository system.
- 1.3. Review DOE efforts to address questions related to possible seismic and igneous events and consequences.
- 1.4. Evaluate data and test results obtained from testing in the enhanced characterization of the repository block (ECRB) and other facilities.
- 1.5. Evaluate the DOE’s efforts to analyze the source term and to estimate what radionuclides will be mobilized and transported through the natural system at what time periods.
- 1.6. Review plans and work carried out on possible analogs for the natural components of the repository system.
- 1.7. Recommend additional work needed to address uncertainties related to estimates of the rate and distribution of water seepage into repository tunnels given anticipated infiltration rates.

- 1.8. Review the DOE's efforts to integrate results of scientific studies related to the behavior of the natural system into repository designs.
- 1.9. Review plans and studies undertaken by the Office of Science & Technology and International (OSTI) related to the natural system.

2. *Performance Goals Related to the Engineered System*

(Dollars in Thousands)		
FY 05	FY 06	FY 07
1,006	1,071	1,101

- 2.1. Review DOE activities related to the engineered system in response to changes in the regulatory compliance period.
- 2.2. Review thermal-mechanical and rock-stability testing on potential conditions in repository tunnels.
- 2.3. 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.
- 2.4. Review the progress and results of materials testing being conducted to address uncertainties about waste package performance.
- 2.5. Review the DOE's analyses of facilities, systems, and component designs, including the transportation, aging, and disposal canister.
- 2.6. Evaluate the accuracy and completeness of the technical bases for repository and waste package designs.
- 2.7. Evaluate the integration of subsurface and repository designs, layout, and operational plans with an overall thermal management strategy.
- 2.8. Assess the integration of scientific studies with engineering designs for the repository and the waste package.
- 2.9. Evaluate the plans and activities of the OSTI related to the engineered system.

3. *Performance Goals Related to Repository System Performance and Integration.*

(Dollars in Thousands)

FY 05	FY 06	FY 07
671	714	735

- 3.1. Identify technical and scientific activities that are on the critical path to reconciling uncertainties related to DOE performance estimates in light of changes in the regulatory compliance period.
- 3.2. Evaluate strengths and weaknesses of TSPA.
- 3.3. Review new data and updates of TSPA models, and identify models and data that should be updated.
- 3.4. Evaluate activities undertaken by the DOE to develop a risk profile for specific radionuclides.
- 3.5. Evaluate the DOE's efforts to develop a realistic analysis of repository performance.
- 3.6. Evaluate the DOE's efforts to analyze the contribution of the different engineered and natural barriers to waste isolation.
- 3.7. Recommend additional measures for strengthening the DOE's repository safety case.
- 3.8. Evaluate the DOE's efforts to develop a feedback loop among performance-confirmation activities and TSPA models and data.
- 3.9. Monitor the DOE's proposed performance-confirmation plans to help ensure that uncertainties are addressed.
- 3.10. Review plans and studies undertaken by the OSTI related to overall performance of the repository.

4. *Performance Goals Related to the Waste Management System*

(Dollars in Thousands)

FY 05	FY 06	FY 07
839	894	917

- 4.1. Evaluate the integration of the repository facility, including the surface and subsurface components.
- 4.2. Evaluate the design of surface facilities, including the fuel handling and aging facilities, and how the design affects and is affected by the thermal management of the repository.

- 4.3. Review DOE procedures for ensuring that waste accepted for disposal has been suitably characterized.
- 4.4. Monitor the DOE's efforts to implement Section 180 (c) of the NWPA.
- 4.5. 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.
- 4.6. Review the DOE's efforts to develop criteria for routing decisions.
- 4.7. Evaluate logistics capabilities of the transportation system.
- 4.8. Monitor progress in implementing new technologies for improving transportation safety for spent nuclear fuel, including transportation, aging and disposal canisters and casks.
- 4.9. Evaluate the DOE's plans for enhancing safety capabilities along transportation corridors, and review the DOE's planning and coordination activities, accident prevention activities, and emergency response activities.
- 4.10. Review the potential and limitations of the total system model.

Budget Request by Object Class

Object Class 11.1, Full-Time Staff: \$1,724,000

The amount requested for full-time permanent staff is based on the requirement to fund a total of 15 positions. Because the Board's technical and scientific evaluations are conducted by Board members supported by professional staff, the Board's enabling legislation authorizes the Chairman to appoint and fix the compensation of not more than 10 senior professional staff members. This request assumes the use of all 10 positions under this authority. In addition, the chairman is authorized to appoint such clerical and administrative staff as may be necessary to discharge the responsibilities of the Board. The other 5 positions funded under this object class are support staff engaged in clerical, secretarial, and administrative activities; development and dissemination of Board publications; information technology, including maintenance of the Board's Web site; public affairs; and meeting logistics for the Board. The small administrative staff supports the very active, part-time Board members and full-time professional staff.

The estimate assumes a 1.022 combined cost-of-living adjustment and locality raise in January 2007 for both general schedule and executive schedule employees.

Object Class 11.3, Other than Full-Time Permanent Staff: \$376,000

The amount requested for this category includes compensation for Board members. Each Board member will be compensated at the rate of pay for Level III of the Executive Schedule for each day the member is engaged in work for the Board. The 11 Board members serve on a part-time basis equaling 2 full-time equivalent positions. The budget assumes that each member will attend 3 full Board meetings, 2 panel meetings, and an average of 2 additional meetings or field trips during the year. This estimate represents an average of 57 workdays per member in FY 2007. This estimate also assumes a 1.022 percent increase in Executive Schedule compensation for employees in this category for FY 2007 (effective January 2007).

Object Class 11.5, Other Personnel Compensation: \$47,000

The amount requested for this category covers approximately 80 hours of staff overtime and performance awards under the Performance Management System approved by the Office of Personnel Management (OPM). Most Board and panel meetings require considerable overtime for on-site meeting logistics and other preparations.

Object Class 12.1, Civilian Personnel Benefits: \$441,000

The estimate for this category represents the government's contribution for employee benefits at the rate of 25.75 percent for staff and 7.65 percent for members.

Object Class 21.0, Travel: \$298,000

The amount requested for this object class includes travel costs for Board members, staff, and consultants traveling to Board and panel meetings, to other meetings (including professional meetings, conferences, and orientation activities) and sites for the purposes of acquiring technical and scientific data, and to Yucca Mountain in Nevada, for reviewing site activities within the scope of the Board's mission. The request is based on 11 Board members attending 3 Board and 2 panel meetings and making on average 2 other trips during the year at an average length of 3 days each, including travel time. In addition, the 10 professional staff members will travel on similar activities an average of 8 trips during the year at an average of 3 days per trip. In FY 2007, it is anticipated that DOE may increase its activities related to planning for transportation and packaging of the waste and designing the repository surface and subsurface facilities. The Board's meetings will increase commensurately and will be held in parts of the country affected by the DOE action.

Object Class 23.1, Rental Payments to the General Services Administration (GSA): \$197,000

The estimate for this object class represents the amount the Board will pay to the GSA for rental of office space totaling 6,288 sq. ft. at an annual rate of \$31.34 per sq. ft.

Object Class 23.3, Communications, Utilities, Miscellaneous: \$24,000

The requested amount represents estimates for telephone service, postage, local courier services, video teleconferencing, FTS long-distance telephone service, the Internet, and mailing services related to management and use of the Board's mailing list.

Object Class 24.0, Printing and Reproduction: \$22,000

The major items in this object class are the publication of reports to the U.S. Congress and the Secretary of Energy, publication of meeting notices in the *Federal Register*, production of press releases announcing meetings and report publication, and production of other informational materials for Board members and the public. All Board meetings are open to the public, and copies of meeting materials are provided. Members of the public who live in rural areas, and who do not have Web access, may be interested in obtaining printed copies of Board documents.

Object Class 25.1, Consulting Services: \$103,000

Consultants will be hired when necessary to support and supplement Board and staff analysis of specific technical and scientific issues. This will enable the Board to conduct the kind of comprehensive technical and scientific review mandated by Congress.

Object Class 25.2, Other Services: \$177,000

This category includes court-reporting services for an estimated five Board or panel meetings, meeting-room rental and related services, maintenance agreements for equipment, professional development, and services from commercial sources. In addition, the Board will contract with part-time technical consultants to supplement and support in-house operations in systems management, Web site management, report production, and editing. Costs of a financial audit to comply with the Accountability of Tax Dollars Act also are included in this category.

Object Class 25.3, Services from Other Government Agencies: \$108,000

This category includes GSA administrative support services (payroll, accounting, personnel, etc.), legal advice from GSA, security clearances through the Office of Personnel Management, and other miscellaneous interagency agreements.

Object Class 26.0, Supplies and Materials: \$62,000

Anticipated expenses include routine office supplies, subscriptions and library materials, and off-the-shelf technical reports and studies.

Object Class 31.0, Equipment: \$91,000

This estimate is for miscellaneous equipment costs, including audiovisual equipment and computer hardware, and computer-network software maintenance. In addition, funds are included to support the Federal Information Security Act, which requires Federal agencies to periodically test and evaluate the effectiveness of their information security policies, procedures and practices. The category also includes continued upgrades to IT security and COOP availability, support to e-gov telecommuting efforts, and technical support of the management of electronic records and e-mails.

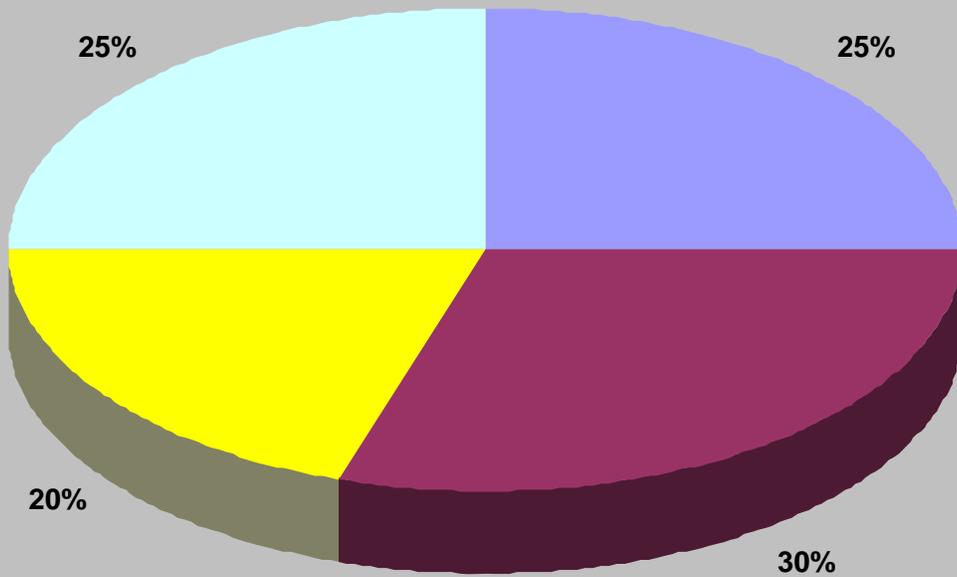
**Nuclear Waste Technical Review Board
Projected 2007 Expenditures
Object Classifications (in thousands of dollars)**

Identification code 48-0500-0-1-271	FY05 ACT	FY06 EST	FY07 REQ
Expenditures			
11.1 Full-time permanent	\$1,605	\$1,686	\$1,724
11.3 Other than Full-Time Permanent	364	366	376
11.5 Other Personnel Compensation	30	47	47
12.1 Civilian Personnel Benefits	401	430	441
21.0 Travel and Transportation	328	312	298
23.1 Rental Payments to GSA	185	184	197
23.3 Communication, Utilities, Miscellaneous	24	26	24
24.0 Printing and Reproduction	16	20	22
25.1 Consulting Services	101	103	103
25.2 Other Services	169	148	177
25.3 Services from Government Accounts	59	69	108
26.0 Supplies and Materials	42	61	62
31.0 Equipment	31	120	91
99.9 Total Obligations	\$3,355	\$3,572	\$3,670

**Nuclear Waste Technical Review Board
Salaries and Expenses
Personnel Summary**

Identification Code 48-0500-0-1-271	05 ACT	06 EST	07 REQ
Total Number of Full-Time Permanent Positions	17	17	17
Total Compensable Work-Years: Full-Time Equivalent	17	17	17

FY 2007 Budget Request Resources



Natural System	25%
(natural barriers at Yucca Mt.)	
Engineered System	30%
(engineered barriers at Yucca Mt.)	
Repository System Performance And Integration	20%
Waste Management System	25%
(Including transportation)	

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 have been 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 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 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 is 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, in any given year the Board engages in the following activities.

- 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 purposes of 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 underway 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 underway 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 analogues 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 currently underway for a small fact-finding meeting with the OCRWM in early 2006 to discuss research results from OSTI work.*

1.5.1. Review the DOE's 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 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 corrosion 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 the DOE's 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 with 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 with 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 the DOE's 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 analogues 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 the DOE's 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 performance confirmation 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 held 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.** 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.** Evaluation: 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 the DOE's 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 suggests that the DOE should determine 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.*

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

- 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 currently a private consultant. His areas of expertise include probabilistic risk assessment and the application of the risk sciences to technology-based industries.

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

- 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.
- David Duquette, Ph.D., is professor and head of the department of Materials Science and Engineering at the 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 the 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 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 the 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 located 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* 4 to 6 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.