

Appendix F

Communication Between the U.S. Nuclear Waste Technical Review Board and Congress

- Letter from David J. Duquette Chair, Executive Committee, to Congressman John M. Shimkus; August 11, 2004.
Subject: Responses to questions related to testimony at a hearing of the Subcommittee on Energy and Air Quality on March 25, 2004



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

August 11, 2004

The Honorable John M. Shimkus
House of Representatives
Washington, DC 20515-1319

Dear Mr. Shimkus:

Thank you very much for your written questions related to my testimony on behalf of the Nuclear Waste Technical Review Board at a hearing before the Subcommittee on Energy and Air Quality on March 25, 2004. The Board's answers to the questions are enclosed.

As you know, the Board is charged by Congress with conducting an ongoing and independent review of the technical and scientific validity of activities undertaken by the Secretary of Energy related to the implementation of the Nuclear Waste Amendments Act of 1987.

Please do not hesitate to contact me or have your staff contact Bill Barnard, Board Executive Director, if you have questions related to the Board's responses to your questions.

Sincerely,

A handwritten signature in black ink that reads "David J. Duquette". The signature is written in a cursive style with a large, looping initial "D".

David J. Duquette
Chairman, Executive Committee

Answers to Questions from Representative John M. Shimkus

[On July 28, 2004, the Board sent a letter to the Department of Energy (DOE) conveying the Board's most recent findings on the potential for localized corrosion of waste packages during the thermal pulse due to the deliquescence of calcium chloride brines. These findings affect the issues raised in the following questions. A copy of the letter is attached and is referenced where appropriate in answers to the questions.]

1. In your testimony of March 25, 2004 you referred to the possibility that corrosion could lead to a "breach" or "breaking" of the waste packages proposed for Yucca Mountain. Can you please define what the terms "breach" and "breaking" mean and explain how such occurrences would affect public health and safety?

Answer:

By "breach," the Board meant penetration through the outer alloy-22 wall of the waste package. A breach that resulted in complete penetration of the waste package could allow radionuclides to exit the waste package. Many factors could affect radionuclide releases, including the extent and proliferation of corrosion, the amount of water that comes into contact with the corroded waste packages, and the mitigative or transmissive characteristics of the unsaturated and saturated zones. The Board has not conducted its own studies related to the effect on public health and safety of a breach of the waste package. However, the Board has referred to the difficulties inherent in making such estimates in several Board documents.

2. (a) Is this concern based on independent work performed by Board members or just on critique of work put forward by DOE and others? (b) How widely is this concern shared in the scientific community? (c) If available, please cite examples of independent research (by the Board or others) substantiating this concern.

Answer:

(a) In accordance with its mandate established in the Nuclear Waste Policy Amendments Act of 1987, the Board evaluates the technical and scientific validity of the DOE's work related to the disposal, transportation, and packaging of spent nuclear fuel and high-level radioactive waste. Although the Board occasionally undertakes its own focused analysis of specific issues, the Board does not conduct experimental research directly. In reaching the conclusions in its October 2003 letter and November 2003 report on the potential for localized corrosion during the thermal pulse, the Board used the DOE's testing conditions and data on potential repository tunnel environments.

On the basis of its interpretation of DOE and other data, the Board concluded that deliquescence-induced crevice corrosion would likely be initiated during the higher-temperature period of the thermal pulse. That conclusion was based particularly on corrosion tests conducted in an aqueous environment rich in calcium chloride. Test results showed clearly that corrosion would take place in that environment when temperatures range roughly between 140°C and 160°C. The results also suggested that the expected mitigating effect of the presence of nitrate ions might not be sufficient to inhibit the corrosion process fully.

However, as stated in the Board's July 2004 letter to the DOE, primarily on the basis of information presented at the Board's May 2004 meeting, it appears unlikely that dust that accumulates on waste package surfaces during the preclosure period would contain significant amounts of calcium chloride or that significant amounts of calcium chloride would evolve on waste package surfaces during the thermal pulse. Consequently, the calcium chloride-rich environment selected for corrosion tests does not appear representative of the conditions that can be expected on waste package surfaces in a Yucca Mountain repository. If calcium chloride is not present, calcium chloride-rich brines will not form by deliquescence, and crevice corrosion due to the presence of such brines in the temperature range of roughly 140°C to 160°C will not occur. Thus, the Board concludes that deliquescence-induced localized corrosion during the higher-temperature period of the thermal pulse is unlikely.

The Board is pleased that the DOE conducted the additional research needed to resolve this extremely important corrosion issue. However, this does not mean that the Board believes that all uncertainties related to corrosion of waste packages have been addressed. For example, in its July 2004 letter, the Board noted other corrosion issues that the Board believes require additional analysis, including (1) a possibility that when temperatures in repository tunnels fall below boiling, localized corrosion could occur in concentrated sodium chloride solutions; (2) the possible presence of ammonium ion and the implications of its presence for corrosion; and (3) the potential for nitrates to be aggressive corrodents in some circumstances. The Board believes that it is important to continue corrosion testing aimed at addressing uncertainties.

(b) The conclusion stated in the Board's October 2003 letter and November 2003 report that localized corrosion would likely be initiated if waste package surface temperatures were above 140°C and if concentrated brines such as would be formed by the deliquescence of calcium chloride were present is consistent with research conducted by others in the scientific community.

(c) Transcripts from the Board's May 2003, September 2003, and May 2004 meetings, which include information from several sources used by the Board to reach the conclusions in its October 2003 letter, its November 2003 report, and its July 2004 letter, are posted on the Board's Web site: www.nwtrb.gov.

3. The fall 2003 letter and report you referred to in your testimony concludes that very aggressive chemistry conditions are likely to exist on the waste package surfaces during the thermal period. (a) In reaching this conclusion, has NWTRB considered the potential for mitigating factors that could make the chemical conditions more benign? (b) Specifically has the board considered the possibility of significant volatilization and removal of chloride in postulated brines as hydrogen chloride (hence reducing the likelihood of high chloride concentrations), the mitigating effects of the presence of aluminosilicate minerals associated with dust in the repository tunnels (and the ability to such minerals to buffer pH values), or scenarios in which conditions would cause the corrosion process, if initiated, to stifle rather than penetrating deep into the waste package material? (c) What is the board's view of these possibilities? Please explain.

Answer:

(a,b,c) In reaching the conclusions presented in its October 2003 letter and November 2003 report on the potential for localized corrosion during the thermal pulse, the Board used the DOE's testing conditions and data on potential repository tunnel environments.

As explained in the answer to question number 2a, it appears unlikely that the dusts in repository tunnels will contain significant amounts of calcium chloride during the thermal pulse. The factors discussed in question 3 that might mitigate the effects of calcium chloride are therefore moot.

4. (a) Do the conclusions that you reached regarding the environment within the proposed repository and the potential impact on the waste packages take into account the need for a confluence of conditions to occur before the waste packages would be adversely impacted? (b) Has the Board specifically evaluated the probability of these conditions occurring? (c) Has the Board taken into account the time dependency of these conditions and what, specifically, is the likelihood that such conditions would occur along the time line required for this to be a concern? (d) Please explain, in detail, these evaluations and results.

Answer:

(a) The Board stipulated that a combination of factors would be necessary for the initiation of deliquescence-induced localized corrosion. Specifically, the Board said that if waste package surface temperatures were above 140°C and if concentrated brines such as would be formed by the deliquescence of calcium chloride were present in repository tunnels, localized corrosion would likely be initiated.

(b,c) The Board has stated that on the basis of information presented at its May 2004 meeting, it appears unlikely that the dust in repository tunnels will contain significant amounts of calcium chloride during the thermal pulse. Consequently, as discussed above, deliquescence-induced localized corrosion of the waste packages is unlikely

during the thermal pulse. However, the Board also stated in its July 2004 letter that the extent to which the DOE has characterized accurately the likely waste package environments is unclear at this point. The DOE's characterization of repository and waste-package environments will continue to be a major focus of the Board's technical and scientific review.

(d) The Board's evaluation is based on basic technical and scientific analysis, its own expert judgment, and research and analysis presented at Board meetings by the DOE and others.

5. Does the Board accept the mandate (per NRC regulation 10 CFR Part 63) that the repository safety analysis must be probability-based?

Answer:

The Board's mandate is to review the technical and scientific validity of DOE activities. The Board's purview does not include policy or regulatory matters. The Board understands that performance estimates are probability based; however, the Board has stated consistently that the DOE's safety case could be strengthened by supplementing repository performance estimates with other lines of argument or evidence—an approach taken by other countries with nuclear waste disposal programs. The result could be increased confidence in the DOE's performance estimates.

6. (a) DOE has conducted total system performance assessments of Yucca Mountain that indicate, even if the waste package fails during the thermal period, the radiological consequences to the public will be a small fraction of the dose limit set forth in EPA and Nuclear Regulatory Commission (NRC) regulations. (b) Yet the NWTRB maintains that a costly design change (to maintain the repository temperature below boiling conditions at all times) needs to be made to prevent such a failure. (c) What safety analysis has NWTRB conducted to indicate that proceeding with the current design has a significant impact on public health and safety? (d) Alternately, what safety analysis has NWTRB conducted to indicate that such a design change will significantly enhance public health and safety? (e) Is NWTRB aware of analyses by NRC indicating that the formation of corrosive brines is independent of repository design temperature? What is NWTRB's view of this analysis?

Answer:

(a) Estimates of radiological consequences due to waste package failure are highly dependent on underlying assumptions. At the Board's September 2003 meeting, the DOE presented simplified studies suggesting that under one set of assumptions, failure of the waste packages could result in exceedence of the dose limit; using different assumptions, the DOE calculated that the repository would meet the regulatory standard if the waste packages failed.

(b,c,d) The Board noted in its November 2003 report that data currently available indicate that perforation of the waste packages caused by localized corrosion is unlikely if waste-package surface temperatures are kept below 95 °C. The Board has not conducted its own studies related to the effect on public health and safety of the DOE's current repository design; the Board's concerns have centered on avoiding potential problems with a major barrier (i.e., the waste package). The Board has stated many times and still believes that there are significant uncertainties associated with the high temperatures in the DOE's current repository design and that keeping temperatures below boiling in repository tunnels could decrease uncertainties and increase confidence in repository performance estimates. According to a 2002 DOE white paper on thermal operating modes, it is not clear that a low-temperature design would be significantly more costly in the long run than a high-temperature design.

(e) Data from the DOE and the NRC indicate that some corrosive brines could exist below 95 °C. In its July 2004 letter, the Board requested that the DOE examine the likelihood that such brines might form and the mechanisms that might lead to the formation of such brines.

7. (a) Is the Board cognizant of the significant expertise of the NRC and its consultants in this area and (b) is the Board prepared to accept NRC's findings regarding whether or not the DOE approach is safe and consistent with regulatory requirements?

Answer:

(a) Yes.

(b) The Board recognizes that the NRC has responsibility for a regulatory finding related to safety and consistency with regulatory requirements. The Board's statutorily established mandate is to evaluate the validity of technical and scientific activities undertaken by the Secretary of Energy and to make recommendations to the Secretary of Energy and Congress. The Board's purview does not include reviewing NRC activities or findings.

Appendix G

U.S. Nuclear Waste Technical Review Board

Strategic Plan: Fiscal Years 2004–2009

(Revised March 2004)

Statement of the 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 spent nuclear fuel and high-level radioactive waste. The Act also established the U.S. Nuclear Waste Technical Review Board as an independent agency within the executive branch of the United States Government. The Act requires the Board to evaluate continually the technical and scientific validity of activities undertaken by the Secretary of Energy related to implementing the Act and to report its findings and recommendations to the Secretary and Congress at least twice yearly. The Board only can make recommendations; it cannot compel the DOE to comply.

Congress created the Board to perform ongoing independent and unbiased technical and scientific evaluation—crucial for public acceptance of decisions related to nuclear waste disposal. 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.

This strategic plan includes the Board's goals and objectives for fiscal years 2004 through 2009. During that period, the DOE plans to develop an application for authorization to construct a repository and to submit it to the U.S. Nuclear Regulatory Commission (NRC). During the next several years, important technical and scientific activities will be undertaken by the DOE aimed at (a) gaining a better understanding of the potential behavior of a Yucca Mountain repository, (b) developing a repository design, (c) reducing technical uncertainties, (d) confirming estimates of repository performance, and (e) developing and implementing plans for a waste management system that includes waste transportation, handling, and packaging and repository operations. In accordance with its statutory mandate, the Board will continue its evaluation of the technical and scientific validity of the DOE's work in these areas. In conducting its evaluation, the Board looks at how components of the repository and waste management systems interact with other elements of the systems. This "systems view" of repository and waste management activities will continue to be critically important because many crucial technical and scientific decisions will be made throughout this period.

Mission

The Board's mission, established in the Nuclear Waste Policy Amendments Act (NWPA) of 1987 (Public Law 100-203), is to "...evaluate the technical and scientific validity of activities [for management of high-level radioactive waste] undertaken by the Secretary after the date of the enactment of the Nuclear Waste Policy Amendments Act of 1987..." By law, the Board will cease to exist not later than one year after the date on which the Secretary begins disposal of high-level radioactive waste or spent nuclear fuel in a repository.

Vision

By performing ongoing and independent technical and scientific peer review of the highest quality, the Board makes a unique and essential contribution to increasing the technical validity of DOE activities related to implementing the Nuclear Waste Policy Act (NWPA) of 1982. The Board also provides essential technical and scientific information to Congress and the public on issues related to the disposal, packaging, and transport of spent nuclear fuel and high-level radioactive waste. The Board performs technical and scientific evaluation of the DOE's work related to (a) gaining a better understanding of the potential behavior of a repository at Yucca Mountain, (b) developing a repository design for safe and efficient repository operations, (c) establishing a program for confirming estimates of repository performance, and (d) developing and implementing plans for a waste management system that includes waste transportation, handling, and packaging and repository operations.

Values

To achieve its goals, the Board conducts itself according to the following values.

- The Board strives to ensure that its members and staff have no real or perceived conflicts of

interest related to the outcome of the Secretary's efforts to implement the NWPA.

- Board members arrive at their conclusions on the basis of objective evaluations of the technical and scientific validity of the Secretary's activities.
- The Board's practices and procedures are open and conducted so that the Board's integrity and objectivity are above reproach.
- The Board's findings, conclusions, and recommendations are technically and scientifically sound and are based on the best available technical analysis and information.
- The Board's findings, conclusions, and recommendations are communicated clearly and in time for them to be most useful to Congress, the Secretary, and the public.
- The Board encourages public comment and discussion of DOE activities and Board findings, conclusions, and recommendations.

Goals and Strategic Objectives

The nation's goals related to disposing of spent nuclear fuel and high-level radioactive waste were set forth by Congress in 1982 in the NWPA. The goals are to develop a 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 disposing of such waste.

In 1987, the NWPA limited repository development activities to a single site at Yucca Mountain in Nevada. The NWPA 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 NWPA. The activities include characterizing the Yucca Mountain site and packaging and transporting spent nuclear fuel and high-level radioactive waste.

The Board's general goals have been established in accordance with its statutory mandate and

with congressional action in 2002 authorizing the DOE to proceed with the submittal of an application to the NRC for authorization to construct a repository at Yucca Mountain. The goals reflect the continuity of the Board's technical and scientific evaluation and the Board's systems view of the repository and of waste management activities.

General Goals of the Board

To accomplish its congressional mandate, the Board has established four general goals.

1. Evaluate the technical and scientific validity of activities undertaken by the DOE related to understanding, testing, analyzing, and modeling geologic and other natural components of a proposed Yucca Mountain repository system. Review DOE activities related to estimating and confirming the performance of the natural components of the repository system.
2. Evaluate the technical and scientific validity of activities undertaken by the DOE related to understanding, testing, analyzing, and modeling the engineered components of a proposed Yucca Mountain repository system. Review DOE activities related to estimating and confirming the performance of the engineered components of the repository system.
3. Evaluate the technical and scientific validity of activities undertaken by the DOE related to understanding and modeling interactions among the components of the natural and engineered repository systems, estimating and confirming the performance of the proposed repository system, and integrating scientific and engineering activities.
4. Evaluate the technical and scientific validity of activities undertaken by the DOE related to planning, integrating, and implementing a waste management system, including the transportation, packaging, and handling of spent nuclear fuel and high-level radioactive waste and the operation of a repository.

Strategic Objectives of the Board

To achieve its general goals, the Board has established the following long-term objectives.

1. Objectives Related to the Natural System

- 1.1. Evaluate the technical and scientific validity of data and analyses related to the contributions of the natural barriers to waste isolation in a Yucca Mountain repository.
- 1.2. Evaluate DOE analyses and investigations related to hydrologic, geologic, geotechnical, seismic, volcanic, climactic, biological, and other natural features, events, and processes at the Yucca Mountain site and at related analogue sites.
- 1.3. Review DOE efforts to increase fundamental understanding of the potential behavior of the repository in a natural system.
- 1.4. Evaluate DOE and other studies and analyses related to repository tunnel environments.*
- 1.5. Review DOE integration of technical and scientific activities related to the natural system.
- 1.6. Review DOE efforts to confirm estimates of natural-system performance, including tests of models and assumptions and the pursuit of independent lines of evidence.

2. Objectives Related to the Engineered System

- 2.1. Evaluate the technical and scientific validity of DOE data and analyses related to the contribution of the engineered system to waste isolation in a Yucca Mountain repository.
- 2.2. Evaluate DOE studies and analyses related to the tunnel environments that will affect the performance of waste packages.*

*This is a shared objective under the natural system and engineered system.

- 2.3. Assess DOE efforts to increase understanding of fundamental corrosion processes in a proposed repository.
 - 2.4. Review waste package designs, including the performance attributes and technical bases for such designs, and assess the need to revise waste package designs on the basis of the results of ongoing technical and scientific studies.
 - 2.5. Evaluate the integration of science and engineering in the DOE program, especially the integration of new data into repository and waste package designs.
 - 2.6. Review DOE activities related to confirming the predicted performance of the engineered system.
3. *Objectives Related to Repository System Performance and Integration*
- 3.1. Evaluate the technical and scientific validity of the DOE's technical basis for its estimates of repository system performance.
 - 3.2. Review the technical and scientific validity of DOE models used to predict repository system performance.
 - 3.3. Evaluate DOE efforts to increase confidence in its estimates of repository performance.
 - 3.4. Evaluate the technical and scientific validity of DOE efforts to gain a more realistic understanding of the interaction of the natural and engineered components of a repository system.
 - 3.5. Evaluate the integration of science and engineering with performance assessment.
 - 3.6. Evaluate the technical bases for the DOE's repository safety case, including efforts to integrate the safety case with multiple lines of evidence and performance confirmation.
- 3.7. Review the development of DOE plans and activities for performance confirmation.
4. *Objectives Related to the Waste Management System*
- 4.1. Review DOE efforts related to the interaction of components of the waste management system from a life-cycle systems perspective, including at-reactor storage, waste acceptance, transportation, and repository design and operations.
 - 4.2. Review the technical and scientific validity of the DOE's plans for safely handling and packaging spent nuclear fuel and high-level radioactive waste for transport to a permanent repository and for disposal in a permanent repository.
 - 4.3. Review the technical and scientific aspects of the DOE's transportation plans.
 - 4.4. Review the technical and scientific validity of the DOE's plans for developing a transportation infrastructure.
 - 4.5. Evaluate design and engineering of the facility components or subsystems that involve innovative features, assumptions, and approaches.
 - 4.6. Review the process through which the DOE provides technical and scientific information to interested parties and includes interested members of the public in the development of waste management plans.

Achieving the Goals and Objectives

The NWPA grants significant investigatory powers to the Board. In accordance with the NWPA, the Board may hold such hearings, sit and act at such times and places, take such testimony, and receive such evidence as it considers appropriate.

At the request of the Board and subject to existing law, the NWPAA directs the DOE to provide all records, files, papers, data, and information requested by the Board, including drafts of work products and documentation of work in progress. According to the legislative history, in providing this access, Congress expected that the Board would review and comment on DOE decisions, plans, and actions as they occurred, not after the fact.

By law, no nominee to the Board may be an employee of the DOE, a National Laboratory, or DOE contractors performing activities involving high-level radioactive waste or spent nuclear fuel. The Board has the power, under current law, to achieve its goals and objectives.

In conducting its ongoing technical and scientific review, the Board takes a “systems view” of the repository and of waste management activities. That view considers how one element of the repository system affects another. Consistent with this approach, the Board has established four panels composed of three or four Board members. As described in the following paragraphs, the purviews of the panels correspond to the Board’s general goals.

1. *Panel on the Natural System*

Panel Goal. Evaluate the technical and scientific validity of activities undertaken by the DOE related to understanding, testing, analyzing, and modeling geologic and other natural components of a proposed Yucca Mountain repository system. Review DOE activities related to estimating and confirming the performance of the natural components of the repository system.

2. *Panel on the Engineered System*

Panel Goal. Evaluate the technical and scientific validity of activities undertaken by the DOE related to modeling, understanding, testing, and analyzing the engineered components of a proposed Yucca Mountain repository system. Review DOE activities related to estimating

and confirming the performance of the engineered components of the repository system.

3. *Panel on Repository System Performance and Integration*

Panel Goal. Evaluate the technical and scientific validity of activities undertaken by the DOE related to understanding and modeling the interactions of natural and engineered repository system components, estimating the performance of the proposed repository system, confirming the performance of the proposed repository system, and integrating scientific and engineering activities.

4. *Panel on the Waste Management System*

Panel Goal. Evaluate activities undertaken by the DOE related to planning, integrating, and implementing a waste management system, including the transportation, packaging, and handling of spent nuclear fuel and high-level radioactive waste and the operation of a repository.

Much of the Board’s information-gathering occurs at open public meetings arranged by the Board. At each meeting, the DOE, its contractors, and other program participants present technical information according to an agenda prepared by the Board. Board members and staff question presenters during the meetings. Time is provided at the meeting for comments from members of the public and interested parties. The full Board holds three or four meetings each year. The Board’s panels meet as needed to investigate specific issue areas. The majority of Board meetings are held somewhere in Nevada.

The Board also gathers information from trips to the Yucca Mountain site, visits to contractor laboratories and facilities, and meetings with individuals working on the project. Board members and staff attend national and international symposia and conferences related to the science and technology of nuclear waste disposal. From time to time, Board members and staff also visit programs in other countries to review best

practices, perform benchmarking, and assess potential analogues.

Although the Board's information-gathering activities are carried out primarily to further the Board's review, they often have the collateral benefit of promoting communication and integration of technical information within the DOE program and facilitating the dissemination of information among interested parties outside the program. Analyses are performed primarily by Board members and the Board's staff. When necessary, the Board hires special expert consultants to perform in-depth reviews of specific technical and scientific topics.

Crosscutting Functions

Several entities and agencies are involved in developing a system for safely packaging, transporting, and disposing of spent nuclear fuel and high-level radioactive waste in a geologic repository at a suitable site. As discussed in the following paragraphs, the Board's ongoing peer review is unique among the organizations involved in managing spent nuclear fuel and high-level radioactive waste.

- *Congress and the Administration, including the Secretary of Energy*, make decisions on national policy and goals and how they will be implemented. The Board's role in this process is to help ensure that policy-makers receive unbiased and credible technical and scientific analyses and information.
- *State and local governments* comment on and perform local oversight of DOE activities. The Board's oversight activities are different in that they are (1) unconstrained by any stake in the outcome of the endeavor besides the credibility of the scientific and technical activities, (2) confined to scientific and technical evaluations, and (3) conducted by individuals nominated by the National Academy of Sciences and expressly chosen by the President for their expertise in the various disciplines represented in the DOE program.

- *Other federal agencies* (in addition to the Board) with roles in the waste management program include the DOE, the NRC, the Environmental Protection Agency (EPA), the Department of Transportation (DOT), and the United States Geological Survey (USGS). The DOE and its contractors are responsible for developing and implementing waste management plans and for conducting analytical and research activities related to licensing, constructing, and operating a repository. The NRC is the regulatory body having responsibility for licensing the construction and operation of a proposed repository and for certifying transportation casks. The EPA is responsible for issuing radiation safety standards that the NRC uses to formulate its repository regulations. The DOT is responsible for regulating the transporters of the waste. The USGS participates in site-characterization activities at the Yucca Mountain site.

The Board's role and its systems approach are unique among these organizations. The Board performs ongoing independent review and expert oversight of the technical and scientific validity of the Secretary of Energy's activities relating to civilian radioactive waste management and communicates its findings and recommendations to Congress, the Secretary, and the public. The Board's technical and scientific evaluations complement the work of other agencies involved in achieving the national goal.

Key External Factors

Some factors that are beyond the Board's control could affect its ability to achieve its goals and objectives. Among them are the following.

- *The Board has no implementing authority.* The Board is by statute a technical and scientific review body that only makes recommendations to the DOE. Congress expected that the DOE would accept the Board's recommendations or indicate why the recommendations could not or should not be implemented. However, the DOE is not legally obligated to

accept any of the Board's recommendations. If the DOE does not accept a Board recommendation, the Board's recourse is to advise Congress or reiterate its recommendation to the DOE, or both. The Board's recommendations and the DOE's responses are included in Board reports to Congress and the Secretary.

- *Legislation and budget considerations could affect nuclear waste policy.* The level of funding provided to the Board affects its ability to comprehensively review DOE activities. Funding levels for the program also may influence activities undertaken by the DOE in a given year or over time. In addition, it is not possible to predict if legislation related to nuclear waste disposal will be passed in the future or how the Board might be affected by such legislation, if enacted.

The Board will evaluate the status of these external factors, identify any new factors, and, if warranted, modify the "external factors" section of the strategic plan as part of the annual program evaluation described below.

Evaluating Board Performance

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, to measure its performance in a given year, the Board has developed performance measures. For each annual performance goal, the Board considers the following.

1. Did the Board undertake the reviews, evaluations, and other activities needed to achieve the goal?

2. Were the results of the Board's reviews, evaluations, and other activities communicated in a timely, understandable, and appropriate way to Congress and the Secretary of Energy?

If both measures were met in relation to a specific goal, the Board's performance in meeting that goal will be judged effective. If only one measure was 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, that will be noted in the evaluation.

The Board will use its evaluation of its own performance from the current year, together with its assessment of current or potential key issues of concern related to the DOE program, to develop its annual performance objectives and performance-based budget request for subsequent years. The results of the Board's performance evaluation are included in its annual summary report.

Consultations

In developing its original strategic plan, the Board consulted with the Office of Management and Budget, the DOE, congressional staff, and members of the public and provided a copy of the plan to the NRC and to representatives of state and local governments. The Board solicited public comment and presented its strategic plan at a session held expressly for that purpose during a public Board meeting in Amargosa Valley, Nevada, on January 20, 1998. During 2003, the Board again solicited and received comment on its revised strategic plan and performance plan. Many of those comments are incorporated in this revision. Copies of the Board's strategic plan, annual performance plans, and performance-based budget for fiscal year 2005 are available in the Board's summary report for 2003 and on the Board's Web site: www.nwtrb.gov.

Appendix H

U.S. Nuclear Waste Technical Review Board Performance Evaluation

Fiscal Year 2004

Evaluating the Board's Performance

The Board believes that measuring its effectiveness by directly correlating Board recommendations with improvements in the technical and scientific validity of Department of Energy (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, to measure its performance in a given year, the Board has developed the following performance measures.

1. Did the Board undertake the reviews, evaluations, and other activities needed to achieve the goal?
2. Were the results of the Board's reviews, evaluations, and other activities communicated in a timely, understandable, and appropriate way to Congress and the Secretary of Energy?

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, that will be noted in the evaluation.

The Board will use its evaluation of its own performance from the current year, together

with its assessment of current or potential key issues of concern related to the DOE program, to develop its annual performance objectives and performance-based budget request for subsequent years. The results of the Board's performance evaluation are included in its annual summary report.

Board's Performance Evaluation for 2004

On the basis of the following evaluation and consistent with the performance measures described in the previous section, the Board's performance for 2004 was found to be effective overall. However, the Board did not have access to TSPA results in 2004. Consequently, performance goals related to reviewing that important aspect of the DOE program were partially met or deferred. Several other performance goals were not possible to meet fully because the DOE did not undertake activities in those areas in 2004. When that is the case, it is noted under the evaluation of the specific performance goal.

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: www.nwtrb.gov.

The Board's performance goals for fiscal year (FY) 2004 were developed to achieve the general goals and strategic objectives in its strategic plan for the 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.

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

1. Performance Goals and Evaluation Related to the Natural System

1.1.1. Review the technical activities and agenda of the DOE's science and technology (S&T) program.

- Evaluation of 1.1.1: The Board held a panel meeting on January 20, 2004, at which it received an update on the S&T program. In a May 3, 2004, letter to the DOE, the Board commended the S&T program for including on its agenda study of the Peña Blanca analogue site in Chihuahua, Mexico. The Board commented on the importance of the S&T program in a letter to the DOE on November 30, 2004, and in its report to Congress and the Secretary of Energy dated December 30, 2004.

1.1.2. 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.

- Evaluation of 1.1.2: The Board held a two-day panel meeting on March 9–10, 2004, at which one day was devoted to reviewing activities undertaken by the DOE related to saturated zone flow and transport. The Board sent a letter to the

DOE on May 3, 2004, in which it commented extensively on fluid flow and radionuclide transport and the potential of the natural barriers to provide a barrier to the migration of radionuclides. Understanding the interaction of the components of the natural system and how they act together to isolate waste was identified as a Board priority in its December 30, 2004, report to Congress and the Secretary of Energy.

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

- Evaluation of 1.1.2: On March 9–10, 2004, the Board held a two-day panel meeting on the natural system at Yucca Mountain. During these two days, the Board heard several presentations on the DOE's approach to estimating the performance of the natural barriers and on supplementing those estimates with additional lines of evidence. Several of the presentations dealt with assumptions underlying the modeling of the natural system. In a May 3, 2004, letter to the DOE, the Board pointed out that unsaturated zone fluid flow and transport predictions are influenced significantly by assumptions inherent in the formulation of the active fracture model. The Board also noted that updating the site-scale model on the basis of these calculations could affect predictions of radionuclide transport times. In the same letter, the Board observed that multiple lines of evidence could be used to supplement conceptual understanding, models used to represent the concepts, and the scenarios predicted by the models. Understanding the interaction of the components of the natural system and how they act together to isolate waste was identified as a Board priority in its December 30, 2004, report to Congress and the Secretary of Energy.

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- 1.2.1. Review DOE efforts to resolve questions related to possible seismic events and igneous consequences.
- Evaluation of 1.2.1: The Board received DOE updates on seismic issues at meetings held May 18, 2004, and September 20, 2004. In follow-up letters to the DOE, the Board noted that the DOE had made progress in developing realistic estimates of ground motions. The Board encouraged the use of sound physical principles to limit ground motions, the integration of technical and scientific studies and activities, and the submission of study results to external peer review. In its December 30, 2004, letter to Congress and the Secretary, the Board noted progress in this area. At its September 20, 2004, meeting, the Board was briefed by representatives of the Electric Power Research Institute on the results of preliminary short-term tests with synthetic magma indicating that the metal used for the waste packages (Alloy-22) may have significant corrosion resistance to some magmas. In a November 30, 2004, letter to the DOE following that meeting, the Board noted that the composition of magmas at Yucca Mountain vary widely. Consequently, the Board believes that the EPRI tests are early indicators, but do not provide a sufficient technical basis for determining the corrosion resistance of the waste package in magma. In the same letter, the Board reiterated that if the repository design is modified to mitigate the effects of igneous activity, such modifications should be evaluated for their effects on repository operation and performance. The Board listed volcanic consequences as an area requiring further study in its December 30, 2004, report to Congress and the Secretary.
- 1.3.1. Evaluate geologic, hydrologic, and geochemical information obtained from the enhanced characterization of the repository block (ECRB) at Yucca Mountain.
- Evaluation of 1.1.2: Evaluation of 1.3.1: The Board noted in its letter to the DOE dated November 30, 2004, that because several significant scientific issues related to a fundamental understanding of the Yucca Mountain site remain unresolved, maintaining access to the ECRB is important. The Board also observed that water collected in the ECRB and the possible presence of chlorine-36 continue to raise questions about water flow inside Yucca Mountain.
- 1.3.2. Evaluate data from the drift-scale heater test.
- Evaluation of 1.3.2: In the Board's November 30, 2004, letter to the DOE, the Board observed that the Drift-Scale Test, which was planned for 8 years, is currently in its "cool down" phase. Observations of hydrogeologic changes in response to heat fluxes in this test will be needed to evaluate models predicting repository performance.
- 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: In its May 3, 2004, letter to the DOE, the Board observed that the Peña Blanca site in Chihuahua, Mexico, could be used as an analogue to test and evaluate Yucca Mountain modeling approaches, the conceptual understanding of the natural systems at the site, and the scenarios predicted by the models. The Board commended the S&T program for its plans to test Yucca Mountain modeling approaches at the Peña Blanca site.
- 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: The Board's May 3, 2004, letter to the DOE contains exten-
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sive comments on work that could be undertaken or continued to address uncertainties related to the natural system, including large-scale hydraulic tests, improvements in characterization of the saturated alluvium, and a better empirical basis for predicting matrix diffusion. The letter also identifies areas of substantial unresolved uncertainty related to the natural system, including colloid-facilitated transport, the active fracture modeling approach, and boundary fluxes, and makes recommendations to reduce the uncertainties. In its July 28, 2004, letter to the DOE, the Board lists examples of uncertainties that need to be addressed to characterize better environments in repository tunnels post closure. Those uncertainties include the conceptual basis for the drift-scale thermohydrologic seepage analysis, the source of water in the ECRB, the effects of drift degradation, and potentially unrealistic parameters in the performance-assessment calculations of seepage.

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

- Evaluation of 1.4.1: The Board observed in its July 28, 2004, letter to the DOE that the extent to which the DOE has characterized accurately the likely waste package environments (i.e. repository tunnel environments post-closure) is unclear at this time. The Board identified accurate characterization of repository tunnels as an area requiring additional attention and a major focus of the Board's ongoing technical and scientific review in its report to Congress and the Secretary, dated December 30, 2004. In its July 28, 2004, letter to the DOE, the Board identified tunnel stability as an uncertainty that needs to be addressed related to postclosure repository tunnel environments.

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: In its November 30, 2004, letter to the DOE, the Board observed that if the repository design is modified to mitigate the effects of igneous activity, such modifications should be evaluated for their effects on repository operation and performance. In a May 3, 2004, letter to the DOE, the Board reiterated its view that an integrated explanation is needed of how elements of the repository act as a system to isolate waste. The Board noted in an April 5, 2004, letter to the DOE that changes in the subsurface design will affect postclosure waste-package temperatures and could exacerbate "cold trap" effects near and in the repository tunnel turnouts. The Board went on to recommend that temperature and relative humidity calculations be revised to reflect repository design changes. The Board commented on the need for thorough integration and close cooperation among diverse technical disciplines (e.g., geochemists and corrosion scientists/engineers) in its July 28, 2004, letter to the DOE.

2. Performance Goals and Evaluation Related to the Engineered System

2.1.1. Monitor the DOE's studies related to the relative contribution of engineered barriers to repository performance.

- Evaluation of 2.1.1: At the Board's meeting on September 20, 2004, the DOE updated the Board on the total system performance assessment (TSPA) process. The TSPA includes estimates of repository performance based on the contributions of various elements of the repository system. The Board identified TSPA as a priority area of evaluation in

its December 30, 2004, report to Congress and the Secretary.

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

- Evaluation of 2.2.1: The Board heard DOE presentations on predicted conditions in repository tunnels during the thermal pulse at its May 18–19, 2004, meeting. In its July 28, 2004, letter to the DOE, the Board identified drift degradation as an important uncertainty affecting the accurate characterization of repository tunnel environments after closure of the repository.

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: The Board devoted most of its meeting on May 18–19, 2004, to a review of DOE activities related to corrosion testing and repository tunnel environments. In a July 28, 2004, letter to the DOE, the Board concluded that a key corrosion issue raised by the Board in 2003 was addressed by DOE data and analyses, indicating that tunnel conditions during the thermal pulse will likely not lead to the initiation of localized corrosion of waste packages due to deliquescence of calcium chloride salts. This conclusion also was included in the Board's report to Congress and the Secretary of Energy, dated December 30, 2004. In its July letter and December report, the Board also commented on additional corrosion issues, including the corrosion resistance of Alloy-22 in magma, the possibility of stress corrosion cracking of the titanium drip shield, and the need to carry out corrosion tests in environments that closely approximate expected conditions in repository tunnels. At its September 30, 2004, meeting, the Board was briefed by representa-

tives of the Electric Power Research Institute on the results of preliminary short-term tests with synthetic magma indicating that the metal used for the waste packages may have significant corrosion resistance to some magmas. In a November 30, 2004, letter to the DOE following that meeting, the Board noted that the composition of magmas at Yucca Mountain vary widely. Consequently, the Board believes that the EPRI tests are early indicators, but do not provide a sufficient technical basis for determining the corrosion resistance of the waste package in magma. The Board suggested that further testing was needed in this area.

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: See evaluation of 2.2.2.

2.3.2. Evaluate the DOE's efforts in identifying analogues for corrosion processes.

- Evaluation of 2.3.2. The Board is unaware of any DOE activities related to identifying natural or engineered analogues for corrosion process in 2004.

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

- Evaluation of 2.4.1. On January 20, 2004, the Board held a panel meeting on repository design, at which it received various updates and briefings on DOE activities in this area. The Board commented extensively on repository design in an April 5, 2004, letter to the DOE following the panel meeting. The Board is unaware of any DOE activities related specifically to developing analytical tools for assessing differences in repository designs. At the Board's meeting on September 20, 2004, the DOE updated the Board on the total system performance assessment

(TSPA) process. The TSPA includes estimates of repository performance *overall*. The Board identified TSPA as a priority area in its December 30, 2004, report to Congress and the Secretary.

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. On January 20, 2004, the Board held a panel meeting on repository design, at which it received various updates and briefings on DOE activities in this area. The Board commented extensively on repository design in an April 5, 2004, letter to the DOE following the panel meeting.

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

- Evaluation of 2.4.4. On January 20, 2004, the Board held a panel meeting on repository design, at which it received various updates and briefings on DOE activities in this area. The Board observed in an April 5, 2004, letter to the DOE following the panel meeting that changes that have been made in the subsurface repository design will affect postclosure waste-package temperatures. In its November 30, 2004, letter to the DOE, the Board encouraged the DOE to analyze how the aging of spent fuel in surface storage at Yucca Mountain would be used to achieve thermal goals as part of a clearly-articulated thermal management strategy. The Board also stated in that letter that it believes that waste handling and surface storage at Yucca Mountain should be viewed and analyzed as parts of an integrated waste management system that begins when waste is accepted for shipment at reactors and other sites and ends after placement of the waste in a repository. This thought was reiterated

in the Board's December 30, 2004, report to Congress and the Secretary.

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

- Evaluation of 2.5.1. In the Board's July 28, 2004 letter to the DOE, the Board emphasized the need for thorough integration and close cooperation among technical disciplines working on the Yucca Mountain program. In its November 30, 2004, letter to the DOE, the Board noted the need to integrate scientific and engineering activities, and to use TSPA to evaluate changes in engineering design or operations for their effects on the overall repository system. The Board noted specifically that repository design changes made to mitigate igneous activity should be evaluated for their effects on repository operation and performance.

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

[Note: TSPA results were not presented by the DOE to the Board in 2004. The Board looks forward to receiving the results of TSPA in 2005. In the meantime, to be prepared to evaluate TSPA results, Board members and staff are reviewing analysis and modeling reports and technical basis documents that will be used to support TSPA-LA.]

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: The Board observed in a letter to the DOE dated November 30, 2004, that the DOE had made progress in developing realistic estimates of ground motions. The Board commented to the DOE in a July 28, 2004, letter that a significant corrosion issue had been addressed. These observations were reiterated in a report to Congress and the Secretary on December 30, 2004. In that report, the

Board also identified a number of issues that require additional attention, including a better understanding of the natural system, an improved understanding of postclosure repository tunnel environments, other corrosion issues, resolution of discrepancies between chlorine-36 studies, improvements in the modeling of volcanic consequences, and work undertaken by the S&T program.

3.1.2. Determine the strengths and weaknesses of TSPA.

- Evaluation of 3.1.2: The Board held a meeting on September 20, 2004, at which it received a comprehensive update from the DOE on the TSPA process. Following the meeting the Board sent a letter to the DOE observing that the presentations at the September meeting highlight the critical need to complete the testing and validation of the process computer models and methods that support TSPA. The Board suggested that TSPA could be used to determine the effects of changes in repository design on other components of the repository system. The Board also indicated that it would like to review the results of TSPA, the technical and integration problems associated with TSPA and model validation activities, and how TSPA activities will be affected by potential changes in the regulatory compliance period. TSPA was identified as a Board priority for the coming year in the Board's December 30, 2004, letter to Congress and the Secretary.

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

- Evaluation of 3.1.3: See evaluation of 3.1.2.

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

- Evaluation of 3.2.1: The Board noted in its May 3, 2004, letter to the DOE that the DOE's approach of dealing with uncertainties related to the performance

of natural barriers by making very conservative assumptions tends to emphasize more-rapid advective transport processes. To address this problem, the Board recommended that the DOE work to increase its fundamental understanding of the behavior of the natural system.

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: The Board noted the critical need to complete the testing and validation of process computer models and methods that support TSPA in its November 30, 2004, letter to the DOE.

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

- Evaluation of 3.3.1: See evaluation of 3.1.2.

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

- Evaluation of 3.3.2: The Board is unaware of any DOE activities in this area in 2004.

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

- Evaluation of 3.3.3: In its May 3, 2004, letter to the DOE, the Board observed that the Peña Blanca site in Chihuahua, Mexico, could be used as an analogue to test and evaluate Yucca Mountain modeling approaches, the conceptual understanding of the natural systems at the site, and the scenarios predicted by the models. The Board commended the S&T program for its plans to test Yucca Mountain modeling approaches at the Peña Blanca site.

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. A Board panel held a two-day meeting on March 9–10, 2004, at

which the DOE presented substantial information related to the contribution of the natural barriers to waste isolation. The Board also participated in a field trip following the meeting. In its May 3, 2004, follow-up letter to the DOE, the Board observed that analyses presented by the DOE suggest that the natural system provides an effective barrier to migration of some radionuclides. However, the Board noted several key hydrogeologic features central to the analyses that are not well understood or are poorly constrained. The Board also reiterated its long-held view that an integrated explanation is needed of how elements of the repository act as a system to isolate waste and recommended that the DOE work to improve its basic understanding of how the natural barriers will perform. The DOE's analysis of the overall contribution of engineered and natural barriers is imbedded in the DOE's TSPA. The Board looks forward to receiving the results of the TSPA, which will illuminate the DOE's analysis of the contributions of the different barriers.

3.5.1. Evaluate technical aspects of value engineering (providing a needed function reliably and at the lowest cost) and performance-related trade-off studies, including criteria, weighting factors, and decision methodologies for such studies; how technical uncertainties are taken into account; and what factors are included or excluded from such studies and why.

- Evaluation of 3.5.1: This performance goal applies specifically to work conducted under a contract to produce a prototype waste package. The contract was awarded by the DOE later than anticipated. Consequently, the work was not undertaken in 2004.

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

- Evaluation of 3.6.1: In a May 3, 2004, letter to the DOE, the Board restated its

long-held view that an integrated explanation is needed of how elements of the repository act as a system to isolate waste. The Board suggested that such an explanation should be based on a fundamental understanding of the system and that multiple lines of evidence and argument can be used to supplement and evaluate TSPA models. These comments were reiterated in the Board's December 30, 2004, report to Congress and the Secretary.

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: The Board did not receive information from the DOE on performance-confirmation activities in 2004.

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

- Evaluation of 3.7.2: See evaluation for 3.7.1.

4. Performance Goals and Evaluation Related to 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: The Board held a panel meeting on January 20, 2004, devoted in its entirety to issues related to the design of the repository, including the surface and subsurface components. On April 5, 2004, the Board sent a follow up letter to the DOE, in which the Board commented extensively on technical and scientific factors affecting the DOE's repository design.

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: The Board referenced the importance of integrating design and operational factors in its letter to the DOE dated April 5, 2004. Specifically, the Board noted that design changes that have been made could affect waste package temperatures and create “cold trap” effects in the repository. The Board recommended that temperature and relative humidity calculations be revised to reflect design changes. The Board held a panel meeting on January 21, 2004, at which it received updates on the status of DOE transportation activities. In a March 28, 2004, follow-up letter to that meeting, the Board observed that waste acceptance may emerge as a key transportation planning consideration. The Board suggested that the DOE work with the utility industry on this important issue. The Board received updates on DOE transportation planning activities at a meeting held May 18–19, 2004, and a panel meeting held October 13–14, 2004. The Board was updated on repository design issues at its September 20, 2004, meeting. In the Board’s November 30, 2004, letter to the DOE, the Board stated its view that waste handling and surface storage at Yucca Mountain should be viewed and analyzed as parts of an integrated waste management system. The Board noted that the DOE’s presentations on waste handling operations illustrated the vital importance of integrating waste management activities as part of facility design. The Board suggested that among other things, the implications of aging of the waste at the Yucca Mountain site should be explained as part of a clearly-articulated thermal management strategy. In its letter to the DOE dated December 1, 2004, the Board suggested that to achieve successful integration of transportation planning activities, it is important for the DOE to identify the entity responsible for each system component as well as the integration of those components. The

Board also observed that DOE presentations at the Board’s October meeting indicated that substantial work remains to be done on integrating waste management system components. Similar comments were included in the Board’s December 30, 2004, report to Congress and the Secretary. In the same letter, transportation activities and integrating the waste management system were included among Board priorities for the coming year.

- 4.1.3. Review the technical and scientific basis of the DOE’s analyses of component interactions in various scenarios, including the degree of integration and redundancy across functional components over time.
 - Evaluation of 4.1.3: See evaluation of 4.1.2.
- 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: The Board suggested that the DOE undertake a review and inventory of infrastructure and facility needs in its letter to the DOE dated March 29, 2004.
- 4.1.5. Review criteria for waste acceptance for storage to ensure that accepted material has been characterized suitably for subsequent disposal.
 - Evaluation of 4.1.5: In its March 29, 2004, letter to the DOE, the Board suggested that the DOE and the utility industry work together to facilitate the determination of cask requirements and transport logistics that are compatible with the waste to be shipped. The Board also recommends a thorough review of waste inventory and acceptance assumptions.
- 4.2.1. Monitor the DOE’s efforts to implement Section 180 (c) of the NWPA.
 - Evaluation of 4.2.1: The Board observed in its March 29, 2004, letter to the DOE

that emergency response capability is seen by states and local communities as a vital component of transportation safety and security. The Board also noted that it will be important for the DOE to demonstrate that it has invested adequate preparation time and financial resources to emergency preparedness. Emergency-response was discussed at the Board's panel meeting on October 13–14, 2004. In a December 1, 2004, letter to the DOE following that meeting, the Board noted the difficulty of forecasting disruptive events, but suggested that the DOE's approach to security risk assessment appears to be organized appropriately. The Board observed that the DOE's 180(c) program appears to be based too much on funding formulas and not enough on ensuring adequate emergency-response capability. The Board recommended that the DOE define a minimally acceptable level of emergency response along each transport route.

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: The Board reviewed DOE transportation activities at its meetings held January 21, May 18–19, and October 13–14, 2004. In its March 29, 2004, letter to the DOE, the Board stated that the DOE's transportation strategic plan lacks the necessary detail for truly understanding the DOE's transportation planning effort. In a letter dated July 28, 2004, the Board noted that the DOE had made real progress in planning a transportation system. The Board's December 1, 2004, letter to the DOE includes more extensive comments on the DOE's transportation plans. For example, the Board suggests that the DOE needs to focus its attention on transportation options

within the state of Nevada for both rail and truck. In particular, the Board suggests that contingency plans need to be developed for higher levels of truck use in the event that a rail spur is not built or is delayed.

4.3.2. Review the DOE's efforts to develop criteria for decisions on transportation mode and routing.

- Evaluation of 4.3.2: The Board notes in its December 1, 2004, letter to the DOE that the DOE should ensure that the technical issues involved in route selection are identified and that sound methods for addressing the issues are developed and applied.

4.3.3. Evaluate logistics capabilities of the transportation system.

- Evaluation of 4.3.3: The Board suggested that the DOE undertake a review and inventory of infrastructure and facility needs in its letter to the DOE dated March 29, 2004.

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

- Evaluation of 4.3.4: The Board reviewed the DOE's model for estimating transportation risk at its meeting held October 13–14, 2004. The Board commented on this issue in a letter to the DOE dated December 1, 2004.

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: See evaluation of 4.1.2.

Appendix I

U.S. Nuclear Waste Technical Review Board Performance Plan

Fiscal Year 2005

Goals and Strategic Objectives

The nation's goals related to disposing of spent nuclear fuel and high-level radioactive waste were set forth by Congress in the NWPA. The goals are to develop a 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 disposing of such waste.

The NWPA limited repository development activities to a single site, Yucca Mountain in Nevada. The NWPA 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 NWPA. The 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, which are presented in the Board's strategic plan for fiscal years (FY) 2004–2009, have been established in accordance with its statutory mandate and with congressional action in 2002 authorizing the DOE to proceed with developing an application to be submitted to the NRC for authorization to construct a repository at Yucca Mountain. The Board's goals reflect the continuity of the Board's ongoing technical and scientific evaluation and the Board's "systems view" of the repository and of waste management activities.

The Board's performance goals for FY 2005, which are included in this document, have been developed to further the achievement of the Board's general goals and strategic objectives. The performance goals have been numbered to correlate with appropriate strategic objectives, and preliminary budget amounts have been allocated to each set of performance goals.

Board Performance Goals for FY 2005

1. Performance Goals Related to the Natural System and Strategy for Achieving the Goals

(Dollars in Thousands)

FY 03	FY 04	FY 05
795	794	800

PERFORMANCE GOALS

- 1.1.1. Review the technical activities and agenda of the DOE's science and technology effort.
- 1.1.2. 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.
- 1.1.3. Review DOE efforts to confirm estimates of natural-system performance and pursue independent lines of evidence, including tests of models and assumptions.
- 1.2.1. Review DOE efforts to resolve questions related to possible seismic events and igneous consequences.
- 1.3.1. Evaluate geologic, hydrologic, and geochemical information obtained from the enhanced characterization of the repository block (ECRB) at Yucca Mountain.
- 1.3.2. Evaluate data from the drift-scale heater test.
- 1.3.3. Review plans and work carried out on possible analogues for the natural components of the repository system.
- 1.3.4. Recommend additional work needed to address uncertainties, paying particular attention to estimates of the rate and dis-

tribution of water seepage into the repository under proposed repository design conditions.

- 1.4.1. Evaluate tunnel-stability studies undertaken by the DOE.
- 1.5.1. Review the DOE's efforts to integrate results of scientific studies on the behavior of the natural system into repository designs.

STRATEGY FOR ACHIEVING GOALS

The Board will accomplish its goals by doing the following.

- Holding three public meetings with the DOE and DOE contractor personnel involving the full Board, and holding meetings of the Panel on the Natural System as needed.
- Reviewing critical documents provided by the DOE and its contractors, including contractor reports, process model reports, and total system performance assessment (TSPA).
- Meeting with contractor principal investigators on technical issues, including those related to climate change, seismic and volcanic events, flow and transport in the unsaturated and saturated zones, seepage, and the biosphere.
- Observing relevant laboratory and site investigations, including those conducted in the exploratory studies facility (ESF), the ECRB, and at Lawrence Livermore National Laboratory, Lawrence Berkeley National Laboratory, and Sandia National Laboratories. Observing other field investigations and visiting potential analogue sites. Visiting countries with nuclear-waste disposal programs and attending national and international symposia and conferences.

2. Performance Goals Related to the Engineered System and Strategy for Achieving the Goals

(Dollars in Thousands)

FY 03	FY 04	FY 05
954	953	960

PERFORMANCE GOALS

- 2.1.1. Monitor the DOE's performance allocation studies.
- 2.2.1. Review thermal testing and rock-stability testing related to potential conditions in repository tunnels.
- 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.
- 2.3.1. Review the progress and results of materials testing being conducted to address uncertainties about waste package performance.
- 2.3.2. Evaluate the DOE's efforts in identifying natural and engineered analogues for corrosion processes.
- 2.4.1. Monitor the DOE's development of analytical tools for assessing the differences between repository designs.
- 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.
- 2.4.3. Evaluate the integration of the subsurface design and layout with thermal management and preclosure facility operations.
- 2.5.1. Assess the integration of scientific studies with engineering designs for the repository and the waste package.

STRATEGY FOR ACHIEVING GOALS

The Board will accomplish its goals by doing the following.

- Holding three public meetings with DOE and contractor personnel involving the full Board, and holding meetings of the Panel on the Engineered System as needed.
- Reviewing critical documents provided by the DOE and its contractors, including contractor reports, process model reports, and TSPA.

- Meeting with contractor principal investigators on technical issues.
- Reviewing DOE documents and databases, paying particular attention to design features developed to promote drainage, control ventilation, and protect workers in the exhaust end of the ventilation system.
- Reviewing the common database (literature, laboratory, and field data) and judging the adequacy of the database for a decision on repository development.
- Observing relevant laboratory investigations, including those conducted at Lawrence Livermore National Laboratory and Lawrence Berkeley National Laboratory. Visiting countries with nuclear-waste disposal programs and attending national and international symposia and conferences.

3. Performance Goals Related to Repository System Performance and Integration and Strategy for Achieving Performance Goals

(Dollars in Thousands)

FY 03	FY 04	FY 05
636	635	640

PERFORMANCE GOALS

- 3.1.1. Identify which technical and scientific activities are on the critical path to reconciling uncertainties related to the DOE's performance estimates.
- 3.1.2. Determine the strengths and weaknesses of TSPA.
- 3.1.3. Evaluate the DOE's treatment of seismic and volcanism issues in TSPA.
- 3.2.1. Evaluate the DOE's quantification of uncertainties and conservatisms used in TSPA.
- 3.2.2. Review new data and updates of TSPA models, and identify models and data that should be updated.

- 3.3.1. Evaluate the DOE's efforts to create a transparent and traceable TSPA.
- 3.3.2. Evaluate the DOE's efforts to develop simplified models of repository performance.
- 3.3.3. Evaluate the DOE's efforts to identify analogues for performance estimates of the overall repository system.
- 3.4.1. Evaluate the DOE's efforts to analyze the contribution of the different engineered and natural barriers to waste isolation.
- 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.
- 3.6.1. Recommend additional measures for strengthening the DOE's repository safety case.
- 3.7.1. Evaluate the DOE's efforts to develop a feedback loop among performance-confirmation activities and TSPA models and data.
- 3.7.2. Monitor the DOE's proposed plans for performance confirmation to help ensure that uncertainties identified as part of the site recommendation process are addressed.

STRATEGY FOR ACHIEVING GOALS

The Board will accomplish its goals by doing the following.

- Holding three public meetings with DOE and contractor personnel involving the full Board and holding meetings of the Panel on the Repository System Performance and Integration, as needed.
- Reviewing critical documents provided by the DOE and its contractors, including contractor reports, process model reports, and the DOE's TSPA.
- Meeting with contractor's principal investigators on technical issues.

- Observing ongoing laboratory investigations, including those conducted at Lawrence Livermore National Laboratory, Lawrence Berkeley National Laboratory, Sandia National Laboratories, and the engineered-barrier test facility. Observing field investigations. Visiting countries with nuclear-waste disposal programs and attending national and international symposia and conferences.

4. Performance Goals Related to the Waste Management System and Strategy for Achieving the Goals

(Dollars in Thousands)

FY 03	FY 04	FY 05
795	794	800

PERFORMANCE GOALS

- 4.1.1. Evaluate the operation of the entire repository facility, including the surface and sub-surface components.
- 4.1.2. Monitor the identification of research needs to support improved understanding of the interaction of components of the waste management system.
- 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.
- 4.1.4. Evaluate the effects of reduced receiving capacity at the repository surface facility on the nationwide transportation system.
- 4.1.5. Review criteria for waste acceptance for storage to ensure that accepted material has been suitably characterized for subsequent disposal.
- 4.2.1. Monitor the DOE's efforts to implement Section 180 (c) of the NWPA.

- 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.
- 4.3.2. Review the DOE's efforts to develop criteria for decisions on transportation mode and routing.
- 4.3.3. Evaluate logistics capabilities of the transportation system.
- 4.3.4. Monitor progress in implementing new technologies for improving transportation safety for spent nuclear fuel.
- 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.

STRATEGY FOR ACHIEVING GOALS

The Board will accomplish its goals by doing the following.

- Holding three public meetings with DOE and contractor personnel involving the full Board, and holding meetings of the Board's Panel on the Waste Management System in appropriate areas of the country.
- Reviewing critical documents provided by the DOE and its contractors, including contractor reports, process model reports, and TSPA.
- Meeting with groups involved in implementing transportation plans, including the NRC, the Department of Transportation, railroad and trucking companies, nonprofit groups, the utilities, and other stakeholders. Visiting countries with nuclear-waste transportation and disposal programs and attending national and international conferences and symposia.

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