
U.S. NUCLEAR WASTE TECHNICAL
REVIEW BOARD

Report to
The U.S. Congress
And
The Secretary of Energy



January to December 1998

Additional copies of this report and previous NWTRB reports are available from the Board's office:
NWTRB, 2300 Clarendon Boulevard, Suite 1300, Arlington, VA 22201-3367.
All NWTRB reports also are available at www.nwtrb.gov, the NWTRB Web site.



UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD
2300 Clarendon Boulevard, Suite 1300
Arlington, VA 22201-3367

April 1999

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

The Honorable Strom Thurmond
President Pro Tempore
United States Senate
Washington, D.C. 20510

The Honorable Bill Richardson
Secretary
U.S. Department of Energy
Washington, D.C. 20585

Dear Speaker Hastert, Senator Thurmond, and Secretary Richardson:

The Nuclear Waste Technical Review Board (Board) submits this *Report to The U.S. Congress and The Secretary of Energy – 1998 Summary and Findings* in accordance with provisions of the Nuclear Waste Policy Amendments Act of 1987, Public Law 100-203, which requires the Board to report its findings and recommendations to Congress and the Secretary of Energy two times each year.

Congress created the Board to evaluate the technical and scientific validity of activities undertaken by the Secretary of Energy in characterizing a site at Yucca Mountain, Nevada, for its suitability as the location of a permanent repository for disposing of spent nuclear fuel and high-level radioactive waste. The Board also reviews the Department of Energy's (DOE) work related to the design of the repository and to the packaging and transport of spent fuel and high-level radioactive waste. In this report, the Board summarizes its major activities during calendar year 1998.

In 1998, the Board closely reviewed the DOE's preparation of the recently issued viability assessment (VA) of the Yucca Mountain site. Overall, the Board agrees with the research needs identified by the DOE in its VA. In particular, the Board supports the DOE's plans to gather information on the amount of water that will eventually seep into repository drifts, whether formations under the repository will retard the migration of radionuclides, and the flow and transport properties of the groundwater that lies approximately 200 meters beneath the repository horizon. The Board also agrees with the DOE on the importance of continuing long-term corrosion tests on materials such as Alloy 22.

In addition to reviewing the VA, the Board reviewed and reported on the hypothesis that there were hydrothermal upwellings at Yucca Mountain and that large earthquake-induced changes in the water table are likely. The Board also organized a workshop to understand better the range of expert opinion about waste package materials, and it reviewed drafts of the DOE's environmental impact statement for Yucca Mountain.

We believe that the information in this report will be useful to policy makers as well as to DOE managers and staff when they make important decisions on the status of the Yucca Mountain site and the research priorities of the civilian radioactive waste management program.

We thank you for this opportunity to present the Board's views. The Board looks forward to assisting the Secretary of Energy and Congress in furthering the goal of safe and cost-effective management of spent nuclear fuel and high-level radioactive waste.

Sincerely,

Jared L. Cohon
Chairman

NUCLEAR WASTE TECHNICAL REVIEW BOARD

Dr. Jared L. Cohon, Chairman
*Carnegie Mellon University
Pittsburgh, Pennsylvania*

Mr. John W. Arendt
*John W. Arendt Associates, Inc.
Oak Ridge, Tennessee*

Dr. Daniel B. Bullen
*Iowa State University
Ames, Iowa*

Dr. Norman L. Christensen, Jr.
*Duke University
Durham, North Carolina*

Dr. Paul P. Craig
*University of California, Davis, Emeritus
Davis, California*

Dr. Debra S. Knopman
*Progressive Policy Institute
Washington, D.C.*

Dr. Priscilla P. Nelson
*National Science Foundation
Arlington, Virginia*

Dr. Richard R. Parizek
*The Pennsylvania State University
State College, Pennsylvania*

Dr. Donald D. Runnells
*Shepherd Miller, Inc.
University of Colorado, Emeritus
Fort Collins, Colorado*

Dr. Alberto A. Sagüés
*University of South Florida
Tampa, Florida*

Dr. Jeffrey J. Wong
*California Environmental Protection Agency
Sacramento, California*

Executive Staff

| | |
|--------------------|----------------------------------|
| William D. Barnard | <i>Executive Director</i> |
| Michael G. Carroll | <i>Deputy Executive Director</i> |

Technical Staff

| | |
|-----------------------|----------------------------------|
| Carlos A.W. Di Bella | <i>Senior Professional Staff</i> |
| Daniel J. Fehringer | <i>Senior Professional Staff</i> |
| Russell K. McFarland | <i>Senior Professional Staff</i> |
| Daniel S. Metlay | <i>Senior Professional Staff</i> |
| Victor V. Palciauskas | <i>Senior Professional Staff</i> |
| Leon Reiter | <i>Senior Professional Staff</i> |

External Affairs Staff

| | |
|-------------------|-------------------|
| Karyn D. Severson | <i>Director</i> |
| Paula N. Alford | <i>Consultant</i> |
| Frank B. Randall | <i>Assistant</i> |

Publications Staff

| | |
|---------------------|------------------------------|
| Ayako O. Kurihara | <i>Editor</i> |
| William D. Harrison | <i>Production Consultant</i> |

Administrative & Support Staff

| | |
|-------------------|-----------------------------|
| Davonya S. Barnes | <i>Staff Assistant</i> |
| Linda Coultry | <i>Staff Assistant</i> |
| Debra K. Hairston | <i>Management Assistant</i> |
| Linda L. Hiatt | <i>Management Assistant</i> |
| Victoria F. Reich | <i>Librarian</i> |

| | |
|---|----|
| Executive Summary | ix |
| Introduction | 1 |
| Chapter 1 Board Oversight of the DOE’s Scientific and Technical Activities at Yucca Mountain | 3 |
| I. Characterization of the Unsaturated Zone. | 3 |
| A. Overview | 3 |
| B. The DOE’s Scientific and Technical Work | 4 |
| C. The Board’s Review Activities | 5 |
| D. The Board’s Conclusions | 7 |
| II. Waste Package Design | 8 |
| A. Overview | 8 |
| B. The DOE’s Scientific and Technical Work | 10 |
| C. The Board’s Review Activities | 10 |
| D. The Board’s Conclusions | 11 |
| III. Repository Design | 11 |
| A. Overview | 11 |
| B. The DOE’s Scientific and Technical Work | 12 |
| C. The Board’s Review Activities | 13 |
| D. The Board’s Conclusions | 13 |
| IV. Characterization of the Saturated Zone | 13 |
| A. Overview | 13 |
| B. The DOE’s Scientific and Technical Work | 15 |
| C. The Board’s Review Activities | 15 |
| D. The Board’s Conclusions | 15 |
| V. Total System Performance Assessment | 16 |
| A. Overview | 16 |
| B. The DOE’s Scientific and Technical Work | 16 |
| C. The Board’s Review Activities | 17 |
| D. The Board’s Conclusions | 17 |
| Chapter 2 Other Board Activities | 19 |
| I. Review of Material Related to Hydrothermal Upwelling at Yucca Mountain. | 19 |
| II. Waste Package Workshop | 21 |
| A. Planning for the Workshop. | 21 |
| B. Alternative Waste Package Designs. | 21 |
| C. Research Needs | 22 |
| D. Conclusions | 22 |

| | | |
|---|---|-----------|
| III. | Transportation | 23 |
| IV. | Environmental Impact Statement for a Yucca Mountain Repository | 23 |
| V. | Strategic and Performance Plans | 24 |
| VI. | Board Visit to Waste Isolation Pilot Plant | 24 |
| VII. | International Activities. | 25 |
| | A. Germany | 25 |
| | B. Sweden | 26 |
| | C. Finland | 27 |
| Abbreviations and Acronyms | | 29 |
| Glossary. | | 31 |
| References | | 35 |
| Appendices | | |
| Appendix A | Nuclear Waste Technical Review Board Members: Curricula Vitae | 41 |
| Appendix B | Meeting List for 1998 | 53 |
| Appendix C | Panel Organization | 55 |
| Appendix D | U.S. Nuclear Waste Technical Review Board Strategic Plan for FY 1998-2003 | 57 |
| Appendix E | U.S. Nuclear Waste Technical Review Board FY 1999 Performance Plan | 63 |
| Appendix F | Communications Between the Board and the OCRWM | 67 |
| Appendix G | Nuclear Waste Technical Review Board Publications | 111 |

Figures

| | | |
|-------------|---|----|
| Figure 1-1. | Cross Section of Yucca Mountain (adapted from Andrews 1998) | 3 |
| Figure 1-2. | Cross Section of 21-PWR Spent-Fuel Waste Package | 8 |
| Figure 1-3. | North-South Cross Section of SZ (after Czarnecki 1989) | 14 |

Executive Summary

In 1987, the U. S. Nuclear Waste Technical Review Board (Board) was created as an independent federal agency by Congress in the Nuclear Waste Policy Amendments Act. The Board was charged with evaluating the technical and scientific validity of the Department of Energy's (DOE) efforts to develop a repository for disposing of high-level radioactive waste and spent nuclear fuel. The Board is required to report its findings and recommendations to Congress and the Secretary of Energy at least twice a year.

This document describes Board activities undertaken in the 1998 calendar year. Chapter 1 presents the Board's views about the DOE's ongoing characterization of the Yucca Mountain site in Nevada as a potential location for a repository. Chapter 2 summarizes other Board activities.

During 1998, the Board closely reviewed the DOE's preparation of the congressionally mandated report, *Viability Assessment of a Repository at Yucca Mountain* (USDOE 1998). The viability assessment (VA) synthesizes information collected by the DOE over the last decade and provides policy-makers with a "snapshot" in time of the following issues:

- preliminary waste package and repository designs
- estimates of repository performance
- additional research that DOE needs to conduct before making a decision on whether to recommend the site for development
- costs of constructing and operating a repository.

Overall, the Board agrees with the research needs identified by the DOE in the VA. In particular, the Board supports the DOE's plans to gather information on the following issues:

- How much water seeps into repository drifts under ambient conditions as well as during the first 1,000 years after waste emplacement, when the rock surrounding the facility is heated?
- Can the zeolitic formations beneath the repository retard the migration of radionuclides to the environment?
- What are the long-term corrosion rates of waste package materials, such as Alloy 22?
- What are the flow-and-transport properties of the groundwater that lies approximately 200 meters beneath the repository horizon?

During 1998, the Board also performed several other activities. It reviewed materials relating to the hypothesis that hydrothermal upwellings are ongoing at Yucca Mountain and that large earthquake-induced changes in the water table are likely. It organized a workshop to understand better the range of expert opinion about highly corrosion-resistant waste package materials. The Board also reviewed drafts of the DOE's environmental impact statement for Yucca Mountain.

Introduction

The federal government formally took on the responsibility for the permanent disposal of high-level radioactive waste and spent nuclear fuel with the passage of the Nuclear Waste Policy Act (NWPA) (U.S. Congress 1982) in 1982. The NWPA designated the U.S. Department of Energy (DOE) the agency for carrying out the federal responsibility. In 1987, Congress passed the Nuclear Waste Policy Amendments Act (NWPAA) (U.S. Congress 1987). That legislation created the U.S. Nuclear Waste Technical Review Board (Board) as an independent federal agency charged with evaluating the technical and scientific validity of the DOE's activities under the NWPA. The Board consists of 11 members who are nominated by the National Academy of Sciences and appointed by the President.

Mined geologic disposal has been and continues to be U.S. policy and is a central tenet of the NWPA. Since the early 1980's, the DOE has directed site-specific studies of as many as nine potential locations for a deep geologic repository for disposing of civilian spent nuclear fuel and high-level radioactive waste. In 1987, the NWPAA restricted site-characterization studies to a single candidate site at Yucca Mountain in Nevada.

Predicting the ability of a repository, anywhere, to isolate radioactive materials for thousands of years is a major technical challenge. The DOE is trying to meet that challenge with detailed studies of the Yucca Mountain site. Of utmost importance is that the appropriate studies are carried out; the scientific work is of the highest quality; and a strategy for isolating the waste can be demonstrated in a techni-

cally credible manner—first, in a decision to select the Yucca Mountain site, and second, in an adversarial licensing process. The goal of the scientific and engineering program is to develop confidence among scientists, engineers, regulators, and the public—especially the citizens of Nevada—that a repository will safely isolate spent nuclear fuel and high-level radioactive waste.

During 1998, the DOE engaged in several significant activities. It completed construction of an exploratory tunnel across the proposed repository block and carried out extensive site characterization. Most significantly, information collected over the last decade was synthesized into a congressionally mandated report, *Viability Assessment of a Repository at Yucca Mountain* (VA) (USDOE 1998).¹ The VA, which was published in December 1998, consists of five volumes.

- Overview
- The preliminary design concepts for the critical elements of the repository and the waste package. The DOE calls them collectively its “reference design.”
- A total system performance assessment (TSPA-VA) based on the reference design and analyses available as of September 1998 (USDOE 1998). The TSPA-VA describes the projected behavior of a repository in the Yucca Mountain geologic setting, based on the data and level of understanding available in mid-1998.

1. Congress required the DOE to prepare the VA in the Energy and Water Development Appropriations Act of 1997 (U.S. Congress 1996).

- A plan and a cost estimate for the remaining work required to complete an application for beginning construction of a repository using the reference design at Yucca Mountain.
- An estimate of the total cost of constructing and operating such a repository.

The Board will comment on the VA in a separate report, but it believes that two comments are in order at this time. First, the VA proved to be a useful management tool that helped the DOE integrate scientific and technical studies and set priorities for further research and design work. Second, as the Board has indicated

several times in the past, the VA should not be viewed as a statement about the suitability of the Yucca Mountain site. Such a statement is premature and must await more site-specific and laboratory research.

This report summarizes the Board's views on activities undertaken in the DOE's radioactive waste management program during 1998. In Chapter 1, the Board presents its assessment of the DOE's site-characterization and engineering design efforts. In Chapter 2, the Board describes its other oversight activities. The appendices to this report contain additional information on the Board, its meetings, and its communications with the DOE.