

Appendices

Appendix A

Nuclear Waste Technical Review Board

Members: Curricula Vitae

Jared L. Cohon, Ph.D., P.E. – Chairman

On June 29, 1995, President Bill Clinton appointed Jared Cohon to serve on the Nuclear Waste Technical Review Board. President Clinton appointed Dr. Cohon chairman on January 17, 1997.

Dr. Cohon is president of Carnegie Mellon University in Pittsburgh, Pennsylvania. He has more than 25 years of teaching and research experience, has written one book, and is author, coauthor, or editor of more than 80 professional publications. Among the awards that Dr. Cohon has received is the 1996 Joan Hodges Queneau Medal for outstanding engineering achievement in environmental conservation, awarded jointly by the American Association of Engineering Societies and the National Audubon Society. Dr. Cohon is a member of Tau Beta Pi, the National Engineering Honor Society, and of Sigma Xi, the Scientific Research Society.

Dr. Cohon brings to the Board special expertise as a national authority on environmental and water resource systems analysis. His current research interests focus on multiobjective programming, a technique for decision-making in situations with multiple conflicting objectives. He also has focused on water resource planning and management in the United States, South America, and Asia and on energy-facility siting, including nuclear waste shipping and storage. In addition to his academic experience, he served as legislative assistant for energy and environment to the Honorable Daniel P. Moynihan, United States Senator from New York, from 1977 to 1978.

Dr. Cohon is a member of the American Geophysical Union, the Institute for Operations Research and Management Science, the American Water Resources Association, and the American Society of Civil Engineers. He has served on several committees for the National Research Council, chairing the studies on the probabilities of extreme floods and on measuring and improving infrastructure. In 1996, he was elected president of the Connecticut Academy of Arts and Sciences.

Dr. Cohon earned a bachelor of science degree in civil engineering from the University of Pennsylvania in 1969. He worked as a construction inspector in Philadelphia and as an engineering assistant for the Philadelphia Water Department before attending the Massachusetts Institute of Technology, where he earned a master's degree in civil engineering in 1972 and a Ph.D. in 1973. He is a registered Professional Engineer. Dr. Cohon began his teaching career in 1973 at Johns Hopkins University, where he served as assistant, associate, and full professor in the Department of Geography and Environmental Engineering and as Assistant and Associate Dean of Engineering and Vice Provost for Research. He became dean of the School of Forestry and Environmental Studies and professor of environmental systems analysis and mechanical engineering at Yale University in 1992. Dr. Cohon assumed his duties as president of Carnegie Mellon University on July 1, 1997.

Dr. Cohon resides in Pittsburgh, Pennsylvania.

John W. Arendt, P.E.

On June 29, 1995, President Bill Clinton appointed John Arendt to serve on the Nuclear Waste Technical Review Board.

John W. Arendt is senior consultant and founder of John W. Arendt Associates, Inc. Created in 1986, the firm offers consultation on program and project management, safety assessments and investigations, quality assurance, standards and regulations for uranium handling and processing, chemical safety audits, and safeguards and accountability. Mr. Arendt is a registered Professional Engineer and a certified nuclear materials manager.

Mr. Arendt brings to the Board five decades of experience in uranium processing, handling, safeguards and accountability, packaging, and transportation and extensive experience in the management of engineering projects, including uranium processing facilities and their quality assurance, quality control, and inspection. He is a member of the Nuclear Standards Board, vice chair of the Nuclear Standards Board Planning Committee, and chair of ANSI Committee N-14 on packaging and transportation of radioactive materials and nonnuclear hazardous wastes.

Mr. Arendt earned a bachelor of science degree in chemical engineering from Marquette University in 1943 and was a research engineer for the Manhattan Project at the University of Chicago from 1943 to 1945. He gained the bulk of his experience with Union Carbide Corporation's Nuclear Division at Oak Ridge, Tennessee, where he began as a production supervisor in 1945 and served in various department and project management positions through 1984. Before founding John W. Arendt Associates, Inc., in 1986, Mr. Arendt was a senior engineer with JBF Associates, Inc., where he provided technical and management assistance in uranium enrichment, standards and regulations, waste management, packaging and shipping, reactor activities, quality assurance, and safety.

Mr. Arendt resides in Oak Ridge, Tennessee.

Daniel B. Bullen, Ph.D., P.E.

On January 17, 1997, President Bill Clinton appointed Daniel Bullen to serve on the Nuclear Waste Technical Review Board.

Dr. Daniel B. Bullen is director of the Nuclear Reactor Laboratory and Associate Professor of Mechanical Engineering, Department of Mechanical Engineering, at Iowa State University in Ames, Iowa. He has been teaching since 1989, served as Nuclear Engineering Program Coordinator at Iowa State University from 1993 to 1996, and has 11 years of industry experience in nuclear engineering and materials science. He has edited and reviewed articles for such professional publications as *Nuclear Technology*, *Journal of the American Ceramic Society*, *American Nuclear Society Transactions*, and *Encyclopedia of Chemical Technology*. He has authored or co-authored more than 50 technical publications and reports and has contributed to two books. He is a registered Professional Engineer in mechanical, metallurgical, and nuclear engineering. Dr. Bullen's honors and awards include membership in Tau Beta Pi (the National Engineering Honor Society), Phi Kappa Phi, Sigma Xi (The Scientific Research Society), and Alpha Nu Sigma (Nuclear Engineering Scholastic Honor Society); a Lilly Teaching Fellowship to the Georgia Institute of Technology (1991); and two Outstanding Professor awards. He has appeared in *Who's Who in California*, *Who's Who in Technology*, and *Who's Who in Science & Engineering*.

Dr. Bullen brings to the Board special expertise in performance-assessment modeling of radioactive waste disposal facilities, engineered barrier system performance assessment, radiolysis effects on spent-fuel dry casks in storage environments, radiation effects on materials, and materials degradation in severe service environments.

Dr. Bullen is a member of the American Nuclear Society; the American Ceramic Society; ASM International; the Materials Research Society; the American Society of Mechanical Engineers; the National Society of Professional Engineers; the Minerals, Metals & Materials Society; the American Society for Engineering Education; and the American Association of University Professors.

In 1978, Dr. Bullen earned a bachelor of science degree in engineering science from Iowa State University. He worked as a research assistant at the University of Wisconsin-Madison while earning master of science degrees in nuclear engineering in 1979 and materials science in 1981, and a Ph.D. in nuclear engineering in 1984. He then worked for Lawrence Livermore National Laboratory as an engineer until 1986, when he became senior engineer for Science & Engineering Associates, Inc., in San Francisco. In 1988, he became president of DG Engineering Associates, providing technical consulting services to Lawrence Livermore National Laboratory. Dr. Bullen moved to North Carolina State University in 1989 as an assistant professor of nuclear engineering and to the Georgia Institute of Technology in 1990 as an assistant professor of mechanical engineering. He moved to Iowa State University in 1992 as an associate professor of nuclear engineering. He assumed his current position in 1993.

Dr. Bullen resides in Ames, Iowa.

Norman L. Christensen, Jr., Ph.D.

On January 17, 1997, President Bill Clinton appointed Norman Christensen to serve on the Nuclear Waste Technical Review Board.

Dr. Norman L. Christensen, Jr., is Professor of Ecology and Dean of the School of the Environment at Duke University in Durham, North Carolina. He has been teaching for more than 23 years and has more than 80 scientific articles and books to his credit. Dr. Christensen is the recipient of the 1977 Duke Endowment Award for Teaching Excellence, the 1991 Distinguished Teaching Award for Trinity College of Arts and Sciences at Duke, and the 1994 Distinguished Scholar-Alumni Award from California State University-Fresno. He was the E.V. Komarek Lecturer at the 1989 Tall Timbers Fire Ecology Conference, was named a Fellow of the American Association for the Advancement of Science in 1993, and the keynote speaker at the 1994 Society of Landscape Ecologists Annual Meeting. Dr. Christensen also has served on more than 25 national and regional panels and commissions and on the editorial boards of *American Midland Naturalist*, *Journal of Vegetation Science*, and *Journal of Wildland Fire*.

Dr. Christensen brings to the Board special expertise in biology and ecology. His research interests include the effects of disturbance on structure and function of populations and communities; comparative biogeochemical and community responses to varying fire regimes; utilization of remote sensing systems (such as synthetic-aperture radar) to evaluate long-term changes in forest ecosystems; and pattern analysis of forest development following cropland abandonment as affected by environment, stand history, and plant demographic patterns. He has written widely on the importance of natural disturbance in the management of forests, shrublands, and wetlands, and he is interested in applying basic ecological theory and models to ecosystem management.

Dr. Christensen is a member of the American Institute of Biological Sciences, the American Association for the Advancement of Science, the British Ecological Society, the Ecological Society of America, Sigma Xi, the Society of American Foresters, and the National Association of Environmental Professionals.

In 1968, Dr. Christensen earned a bachelor's degree in biology from Fresno State College. He earned a master's degree in biology from Fresno State College in 1970 and a Ph.D. in biology from the University of California-Santa Barbara in 1973. He began his teaching career as an assistant professor in the Department of Botany at Duke University in 1973. He became an associate professor in 1979 and was elevated to full professor in 1987. He moved to his current position in 1991.

Dr. Christensen resides in Chapel Hill, North Carolina.

Paul P. Craig, Ph.D.

On January 30, 1997, President Bill Clinton appointed Paul Craig to serve on the Nuclear Waste Technical Review Board.

Dr. Paul P. Craig is Professor of Engineering Emeritus at the University of California, Davis, and is a member of the university's Graduate Group in Ecology Environmental Policy. He has more than 21 years of teaching experience and has more than 100 publications to his credit. Dr. Craig is a member of the Sierra Club's National Energy Committee, the Advisory Council to the San Francisco Bay Area Air Quality Management District, Phi Beta Kappa, and the American Association for the Advancement of Science and is a Fellow of the American Physical Society. His awards include a John Simon Guggenheim Memorial Foundation Fellowship and a National Science Foundation Meritorious Service Award.

Dr. Craig brings to the Board special expertise and research interest in energy policy issues associated with global environmental change. His current work focuses on developing the Presidio Pacific Center, a new institution emphasizing sustainable development in Pacific Rim nations.

In 1954, Dr. Craig earned a bachelor's degree in math and physics from Haverford College. He earned a Ph.D. in Physics from the California Institute of Technology in 1959. He began his career as a staff scientist at Los Alamos National Laboratory in 1959, moved to Brookhaven National Laboratory in 1962 as a physicist and group leader, and became deputy and acting director of the Office of Energy Research and Development Policy of the National Science Foundation in 1971, where he provided policy analysis support to the President's science advisor and to the Office of Management and Budget. Dr. Craig became director of the University of California Council on Energy and Resources in 1975 and professor of engineering at the University of California, Davis, in 1977. He received his emeritus designation in 1994. Until his appointment to the Nuclear Waste Technical Review Board, Dr. Craig was a Lawrence Berkeley National Laboratory Participating Guest Scientist (beginning in 1976) and a member of the National Academy of Sciences-National Research Council Board on Radioactive Waste Management.

Dr. Craig resides in Martinez, California.

Debra S. Knopman, Ph.D.

On January 17 1997, President Bill Clinton appointed Debra Knopman to serve on the Nuclear Waste Technical Review Board.

Dr. Debra S. Knopman is director of the Center for Innovation and the Environment of the Progressive Policy Institute in Washington, D.C. She has more than 24 publications in scientific and technical journals to her credit. Dr. Knopman is a member of the National Research Council's Commission on Geosciences, Environment, and Resources and served briefly on the Board on Radioactive Waste Management and the Panel for the Review of the DOE Environmental Restoration Priority System before accepting a position in the Clinton Administration in 1993. She also is a member of the American Geophysical Union. Dr. Knopman was a 1978-1979 Henry Luce Foundation Scholar.

Dr. Knopman brings to the Board special expertise in hydrology, environmental and natural resources policy, systems analysis, and public administration.

In 1975, Dr. Knopman earned a bachelor's degree in chemistry from Wellesley College. She completed a master of science degree in civil engineering from the Massachusetts Institute of Technology in 1978 and earned a Ph.D. from the Department of Geography and Environmental Engineering at The Johns Hopkins University in 1986. Dr. Knopman began her career in 1975 as a freelance science writer and editor in Israel and the United States. She served with the Joint Commission on Rural Reconstruction and the Yunlin Irrigation Association as a Luce Scholar in Taiwan from 1978 to 1979 and as legislative assistant for energy and environmental issues to Senator Daniel P. Moynihan in Washington, D.C., from 1979 to 1980. She was a professional staff member of the U.S. Senate Committee on Environment and Public Works from 1980 to 1983 and moved to the U.S. Geological Survey in 1984, beginning as a student assistant and progressing through being a research hydrologist to becoming chief of the systems analysis branch. In 1993, Dr. Knopman was appointed Deputy Assistant Secretary for Water and Science, Department of the Interior. She assumed her current position in 1995.

Dr. Knopman resides in Washington, D.C.

Priscilla P. Nelson, Ph.D.

On January 17, 1997, President Bill Clinton appointed Priscilla Nelson to serve on the Nuclear Waste Technical Review Board.

Dr. Priscilla P. Nelson is acting senior engineering coordinator and program director for the Directorate for Engineering at the National Science Foundation. She formerly was professor of civil engineering at the University of Texas at Austin. Dr. Nelson has more than 15 years of teaching experience and more than 100 technical and scientific publications to her credit. She has served as a member of the U.S. National Committee for Rock Mechanics, the U.S. National Committee for Tunneling Technology, and the Board on Radioactive Waste Management, all activities of the National Research Council. She is past president of the American Rock Mechanics Association, governor of the Geo-Institute of the American Society of Civil Engineers, and an active member of the Underground Technology Research Council, the American Underground Construction Association, the Association of Engineering Geologists, the International Tunnelling Association, and many other professional organizations. Her honors and awards include the Exxon Teaching Fellowship at the University of Texas at Austin (1985-1987), the Case Studies Award from the U.S. National Committee for Rock Mechanics (1988), the Haliburton Education Foundation Award of Excellence (1991), the Basic Research Award from the U.S. National Committee for Rock Mechanics (1993), and election to The Moles, an association of the heavy-construction industry (1995). Dr. Nelson received the Director's Award for Collaborative Integration and the Meritorious Service Award (1997) and the Outstanding Engineer of the Year (1998) from the National Science Foundation.

Dr. Nelson brings to the Board special expertise in rock engineering and underground construction. Her current research interests lie in the development of a case-history-based simulation platform for probabilistic risk analysis and prediction of project performance in underground construction.

In 1970, Dr. Nelson earned a bachelor's degree in geological sciences from the University of Rochester. She completed master's degrees in geology from Indiana University in 1976 and in structural engineering from the University of Oklahoma in 1979. She was awarded a Ph.D. in geotechnical engineering by Cornell University in 1983. Dr. Nelson's career experiences include a teaching appointment at the Polytechnic Institute of Guayaquil, Ecuador, arranged through the Peace Corps (1974). She also served as a field engineer during construction of the Trans-Alaska Pipeline for the Alaskan Resource Sciences Corporation from 1975 to 1977. From 1983 through 1996, Dr. Nelson was a member of the faculty in the Department of Civil Engineering at the University of Texas at Austin, resigning her appointment as full professor and holder of the John Focht Teaching Fellowship in 1996 to join the National Science Foundation.

Dr. Nelson resides in Arlington, Virginia.

Richard R. Parizek, Ph.D., P.G.

On February 11, 1997, President Bill Clinton appointed Richard Parizek to serve on the Nuclear Waste Technical Review Board.

Dr. Richard R. Parizek is a professor of geology and geoenvironmental engineering at The Pennsylvania State University; president of Richard R. Parizek and Associates, consulting hydrogeologists and environmental geologists; and a registered Professional Geologist (P.G.). He has more than 36 years of teaching experience and numerous journal publications to his credit. Dr. Parizek is a member of the American Association for the Advancement of Science, the American Geophysical Union, the American Institute of Hydrology, the Geological Society of America, and Sigma Xi. His awards include a cooperative fellowship from the National Science Foundation (1960), a shared Superior Achievement Award from the U.S. Environmental Protection Agency (1976), the Karl M. Mason Award (1977), the Clearwater Conservancy Award (1985), the Matthew J. and Anne C. Wilson Outstanding Teaching Award (1986) at The Pennsylvania State University, and the medal for distinguished service to environmental science and engineering from the Institute of Meteorology and Water Management, Warsaw, Poland (1991). Dr. Parizek also was appointed an administrative law judge of the Atomic Safety and Licensing Board Panel of the U.S. Nuclear Regulatory Commission in 1990, a position he relinquished upon appointment to the Nuclear Waste Technical Review Board.

Dr. Parizek brings to the Board special expertise in hydrogeology and environmental geology. His research interests include hydrogeology of karst-fractured, rock-dominated, and glaciated terranes, factors controlling groundwater occurrence and movement, and the relationship between land use and groundwater pollution resulting from disposal of nuclear waste and other hazardous substances.

In 1956, Dr. Parizek earned a bachelor's degree in geology from the University of Connecticut. He earned a master of science degree in geology in 1960 and a Ph.D. in geology in 1961, both from the University of Illinois. Dr. Parizek began his career as research assistant with the Illinois State Geological Survey in 1956. He began teaching in 1961 as assistant professor of geology and geophysics at The Pennsylvania State University. He achieved full-professor status in 1971 and continues to teach in the Department of Geosciences at The Pennsylvania State University. Dr. Parizek also has been a visiting scientist with the U.S. Geological Survey and a visiting scholar at Stanford University, University of Nevada-Reno, Changchun College of Geology and Institute of Karst Geology in the People's Republic of China, Radiohydroecological Center of the Ukrainian Academy of Sciences, and National Cheng Kung University in Taiwan.

Dr. Parizek resides in State College, Pennsylvania.

Alberto A. Sagüés, Ph.D., P.E.

On January 17, 1997, President Bill Clinton appointed Alberto Sagüés to serve on the Nuclear Waste Technical Review Board.

Dr. Alberto A. Sagüés is Professor of Materials Engineering, Department of Civil and Environmental Engineering, at the University of South Florida and is a registered Professional Engineer. He has more than 15 years of teaching experience and more than 100 publications to his credit. From 1988 to 1992, Dr. Sagüés served as an expert task group member of the Strategic Highway Research Program of the National Research Council. He has made technical presentations to professional and scientific audiences across the United States and Canada and throughout Europe and Central and South America. He holds three patents related to corrosion control. Dr. Sagüés is a member of ASM International (formerly the American Society for Metals), the National Association of Corrosion Engineers, the Electrochemical Society, the American Society for Testing and Materials, and the American Concrete Institute.

Dr. Sagüés brings to the Board special expertise in corrosion and materials engineering, physical metallurgy, and scientific instrumentation. His current research interests are in corrosion of reinforcing steel in concrete and durability forecasting of civil infrastructure.

A native of Argentina, Dr. Sagüés earned an undergraduate degree in physics from the National University in Rosario, Argentina, in 1968. He earned a Ph.D. in metallurgy from Case Western Reserve University in Cleveland in 1972. A citizen of the United States since 1979, Dr. Sagüés began his career as a visiting assistant professor at Columbia University in 1972, engaged in postdoctoral research in 1973, and was a guest scientist at the Solid State Research Institute of Jülich Nuclear Research Center in West Germany from 1974 to 1976. He served as a research associate at Argonne National Laboratory from 1976 to 1978 and as senior metallurgist, manager, and associate laboratory director of the Kentucky Center for Energy Research Laboratory from 1978 to 1985. At the same time, he continued his teaching career at the University of Kentucky. In 1985, he moved to the University of South Florida as an associate professor. Dr. Sagüés became a full professor and assumed his current position in 1991.

Dr. Sagüés resides in Lutz, Florida.

Jeffrey J. Wong, Ph.D.

On June 29, 1995, President Bill Clinton appointed Jeffrey Wong to serve on the Nuclear Waste Technical Review Board.

Dr. Jeffrey J. Wong is chief of the Human and Ecological Risk Division of the Department of Toxic Substances Control, California Environmental Protection Agency. Dr. Wong has more than 14 years of experience in toxicology, including assessment of exposure risks at hazardous waste sites; hazardous waste treatment, storage, and disposal facilities; and hazardous material spills and accidents. He also has worked with the California Department of Justice in forensic toxicology. Dr. Wong was a National Institutes of Environmental Health Sciences Predoctoral Fellow in environmental toxicology and was the recipient of the American Academy of Forensic Sciences Regional Award in Toxicology in 1984.

Dr. Wong brings to the Board extensive experience in risk assessment and scientific team management. He recently served as the risk evaluation expert on the external expert review panel to the Consortium for Environmental Risk Evaluation, a program of Tulane and Xavier universities. Dr. Wong also has served on National Academy of Sciences/National Research Council committees relating to remedial action for hazardous waste sites and the U.S. Department of Energy's environmental restoration program. He is a member of the editorial board of *Journal of Contaminated Soils* and the advisory board for the Association for the Environmental Health of Soils and is a councilor for the Northern California Chapter of the Society for Risk Analysis.

Dr. Wong earned a bachelor of arts degree in bacteriology in 1973, a master of science degree in food science and technology in 1976, and a doctorate in pharmacology and toxicology in 1981, all from the University of California, Davis. He worked for the California Department of Justice as a senior forensic toxicologist after his doctoral work, moving to the California Department of Food and Agriculture as a staff toxicologist before beginning his career with the California Environmental Protection Agency in July 1985.

Dr. Wong resides in Sacramento, California.

Appendix B

Meeting List for 1997

Minutes are available for Board business meetings. Transcripts are available for Board meetings and panel meetings.

January 28-29, 1997

Full Board Meeting

Pahrump, Nevada

Topics

- overview of program progress
- technical issues associated with the need for an east-west crossing
- national and local transportation issues
- Nye County scientific studies
- proposed revisions to siting guidelines
- 10 CFR 960
- making performance assessment “transparent” to scientific and lay communities

January 30, 1997

Board Business Meeting

Pahrump, Nevada

June 24, 1997

Board Business Meeting

Las Vegas, Nevada

June 25-26, 1997

Full Board Meeting

Las Vegas, Nevada

Topics

- EPA standards and technical site assessment plans for TSPA-VA (changes from TSPA-95)
- 10 CFR 960 (with congressional staff participation)
- design and operations update
- transport modeling results in light of EPA standard

- maturing waste isolation strategy
- progress report on generic plans for interim storage
- scientific and technical comments on priority research and engineering objectives

October 21, 1997

Meeting of the Panel on the Environment, Regulations, and Quality Assurance

Fairfax, Virginia

Topic

- DOE interim performance standard for a Yucca Mountain repository

October 22-23, 1997

Full Board Meeting

Fairfax, Virginia

Topics

- Yucca Mountain update
- repository underground design
- repository operations
- waste package design
- DOE-owned spent nuclear fuel

October 23-24, 1997

Board Business Meeting

Fairfax, Virginia

November 19-20, 1997

Meeting of the Panel on the Waste Management System

Arlington, Virginia

Topic

- spent-fuel transportation safety

December 3-4, 1997

Yucca Mountain Tour

Amargosa Valley, Nevada

Topics

- paleohydrology and geology
- underground testing
- environmental resources

December 17, 1997

Meeting of the Panel on the Repository

Augusta, Georgia

Topics

- Spent fuels: DOE-owned, naval, highly enriched-uranium (HEU)
- glass manufacture and glass-disposal packaging

Appendix C

Panel Organization

1. Panel on Site Characterization

Chairman: Dr. Debra S. Knopman
 Members: Dr. Priscilla P. Nelson
 Dr. Richard R. Parizek
 Dr. Alberto A. Sagüés

Staff: Leon Reiter*
 Russell K. McFarland
 Victor V. Palciauskas

2. Panel on the Repository

Chairman: Dr. Priscilla P. Nelson
 Members: Mr. John W. Arendt
 Dr. Daniel B. Bullen
 Dr. Alberto A. Sagüés

Staff: Russell K. McFarland*
 Carlos A. W. Di Bella
 Victor V. Palciauskas

3. Panel on the Waste Management System

Chairman: Mr. John W. Arendt
 Members: Dr. Daniel B. Bullen
 Dr. Norman L. Christensen, Jr.
 Dr. Paul P. Craig
 Dr. Debra S. Knopman

Staff: Michael G. Carroll*
 Carlos A. W. Di Bella
 Daniel S. Metlay

4. Panel on the Environment, Regulations, and Quality Assurance

Chairman: Dr. Jeffrey J. Wong
 Members: Mr. John W. Arendt
 Dr. Norman L. Christensen, Jr.
 Dr. Paul P. Craig
 Dr. Debra S. Knopman

Staff: Daniel J. Fehring*
 Daniel S. Metlay

5. Panel on Performance Assessment

Chairman: Dr. Daniel B. Bullen
 Members: Dr. Paul P. Craig
 Dr. Richard R. Parizek
 Dr. Alberto A. Sagüés
 Dr. Jeffrey J. Wong

Staff: Carlos A. W. Di Bella*
 Daniel S. Metlay
 Victor V. Palciauskas
 Leon Reiter

*Staff coordinator

Appendix D

Department of Energy's Responses to the Recommendations in the Board's 1996 Summary Report

As part of its effort to keep the Nuclear Waste Technical Review Board informed of its progress, the Department of Energy (DOE) submits a summary of initial responses to recommendations the Board makes in its reports. Included here are the DOE's responses to the NWTRB's 1996 Summary Report. Inclusion of DOE's responses does not imply Board concurrence.

**Department Response to the Recommendations of
the Nuclear Waste Technical Review Board's
1996 Summary Report to the U.S. Congress
and the Secretary of Energy, April 1997**

PROGRAM OVERVIEW RECOMMENDATIONS

Recommendation 1:

A decision to locate the nation's primary centralized storage facility for spent fuel at or near Yucca Mountain should be deferred until the suitability of the site as a repository location has been determined.

Response:

The Administration is committed to resolving the complex and important issue of nuclear waste storage in a timely and sensible manner consistent with the Nuclear Waste Policy Act, sound science, and the protection of public health, safety, and the environment. The Administration believes that a decision on the siting of an interim storage facility should be based on objective science-based criteria and should be informed by the viability assessment of the Yucca Mountain candidate repository site, to be issued in late 1998.

Recommendation 2:

To the extent possible under the market-driven initiative, efforts to develop storage and transportation casks should retain the advantages (e.g., standardization) previously offered by the multipurpose canister concept.

Response:

The Program has attempted to retain advantages previously offered by the multi-purpose canister concept, such as limiting unnecessary spent fuel handling, with its concomitant reduction in occupational exposure, in framing the draft Request for Proposal (RFP) for the acquisition of Waste Acceptance and Transportation Services. To this end, the acquisition strategy includes requirements to accept canistered spent nuclear fuel (SNF) from those utilities that have placed their fuel in canisters suitable for storage and transportation. Additionally, the RFP includes performance requirements for storage of the SNF canisters at a potential licensed Federal storage facility without requiring that the SNF be repackaged. The Program is encouraging utilization of such systems in the market-driven strategy by considering the inclusion of such systems as standard waste forms under the terms of the standard disposal contracts and entertaining potential compensation for avoided costs to the Federal system associated with the use of such utility-supplied equipment. Similarly the Program intended to compensate Purchasers or contractors for the avoided costs of canisters that prove to be disposable under the U.S. Nuclear Regulatory Commission's (NRC) licensing process. The timing of such compensation would be tied to the utilization of such canisters in waste disposal packages.

RECOMMENDATIONS FOR HYDROLOGY, RADIONUCLIDE TRANSPORT AND PERFORMANCE ASSESSMENT

Recommendation 3:

Before making a determination of the suitability of the Yucca Mountain site for a repository, the Department should complete additional studies of the area west of the current exploratory studies facility, where wastes would be emplaced, to determine its geologic, hydrologic, and geochemical properties. The best way to obtain the needed information is excavation of a tunnel westward across the proposed repository block.

Response:

The Department has in its planning base additional studies which will focus on the areas west of the Exploratory Studies Facility. The Department recently undertook a planning effort to determine the feasibility of moving forward in time the schedule for these activities. The goal of this enhanced site characterization effort is to develop additional information needed to complete the assessment of site suitability. In addition to determining the specific location, alignment, length, size and cost of the drift, the detailed planning effort developed an approach for test alcoves, surface and subsurface boreholes, and other scientific investigations.

The Enhanced Characterization of the Repository Block (ECRB) 90-day Planning Effort Interim Report was provided to the Board on July 18, 1997. The Interim Report is a pre-decisional document that provides an analysis of options and possible configurations for the ECRB activity. The Department decided on August 20, 1997 to support this effort. Although Congressional FY 1998 budget reductions of \$30 million have unfortunately reduced our original 1998 planned science experiments in the tunnel and alcoves, we expect valuable information to support the design and performance assessment activities to be obtained.

Recommendation 4:

The Department should make a concerted effort to ensure that future TSPAs are transparent and valid, that uncertainty is treated properly, and that any peer review of performance assessment elicitation of expert judgment is objective.

Response:

The Department agrees and is taking a new approach to ensure that the next iteration of total system performance assessment for the viability assessment (TSPA-VA) is transparent and technically defensible. This approach should enhance confidence in the analyses and help communicate the complexities of predicting system behavior to a wide range of audiences (e.g., technical peers, regulatory and oversight bodies, and decision-makers within the Department, and Congress). Specific activities include:

(1) workshops with participation by key Yucca Mountain Project scientists and engineers to ensure the completeness of models and approaches to model abstractions used in the TSPA;

(2) detailed documentation of each key process model used as input to the abstracted models used in TSPA;

(3) formal expert elicitation using both Project and external experts to assist in quantifying the uncertainty in alternative model hypotheses and parameter distributions in some of the key elements feeding into TSPA; and

(4) a participatory external peer review of the development and documentation of the TSPA-VA.

To date, the Department has conducted nine workshops on the key process models that will form the basis for the TSPA-VA. Participants in the workshops have included scientists, engineers, process model developers, performance assessment analysts, and technical managers. Observers of the workshops have included the NRC, the Board, the U.S. Environmental Protection Agency, and members of the TSPA-VA Peer Review Committee. These workshops have identified and prioritized the key issues impacting long-term performance. The workshops have also fostered an integrated, Project-wide approach to addressing these key issues.

The technical defensibility of the TSPA will depend on the process models that form the bases for the abstractions in the TSPA model. Each of the key process models is being revised and documented, including a discussion of the scientific bases (i.e., validity) of the model. It is recognized that establishing model validity in the classic sense of making a prediction and running a test or experiment to validate that prediction is not possible when very slow geologic processes are involved over large scales. As suggested by the NRC in 10 CFR 60, however, where appropriate, models will be evaluated by comparisons to in situ, laboratory, or natural analog information. Model documentation also will include a discussion of the confidence in the model, alternative interpretations, and the uncertainty in the model to making predictions for long-term performance.

For some key process models, the Department has initiated formal expert elicitation using both program and external experts. These elicitation are following the process outlined in the "NRC Branch Technical Position on the Use of Expert Elicitation in the High-Level Radioactive Waste Program." In addition to the Probabilistic Volcanic Hazard Assessment and the Probabilistic Seismic Hazard Assessment, expert elicitation are being conducted on (1) the unsaturated zone flow model; (2) the waste package degradation model; and, (3) the saturated zone flow and transport model.

Finally, the TSPA-VA will be formally reviewed by an external peer review body. As noted by the Board in its Report, this peer review will be a participatory peer review of developing and abstracting the process models and conducting and documenting the TSPA-VA. When the TSPA-VA document is completed, the peer review will become a more traditional "late-stage review." The final results of the peer review will be used to help develop the TSPA for license application and are expected to help the traceability and transparency of the TSPA.

Recommendation 5:

The Department should consider ways of increasing public understanding and acceptance of TSPAs. One possibility is to establish processes, modeled on the lines suggested in a recent report by the congressionally chartered Commission on Risk Assessment and Risk Management, for involving and engaging the public.

Response:

The Department will carefully consider the Board's recommendation and is already planning 1998 and out-year activities that specifically address the creation of documents and materials that communicate more

effectively to less technical audiences. The Department recognizes that communicating with the public is both a difficult and a serious responsibility, and in response to this Board recommendation has studied the 1997 "Framework for Environmental Health Risk Management" document and also the other report cited, the 1996 National Academy of Sciences/National Research Council report by their Committee on Risk Characterization.

We note that these two reports address the entire societal risk-informed decision-making process, and both emphasize the need to involve stakeholders early and meaningfully in the risk management process. The Board's report text, as well as this specific recommendation, suggest that the DOE use these reports to help define more effective public involvement processes that may aid external understanding and acceptance of TSPAs.

Appendix B of the 1996 report by the Committee on Risk Characterization suggests several methods and fairly catalogs their positive and negative attributes. The Department is currently looking at these methods and their potential applicability to building public understanding and, if possible, acceptance of the Department's future TSPAs. Several of the suggested methods may be appropriate and will receive consideration. In particular: (a) focus groups to obtain in-depth feedback from a representative citizens' group on the effectiveness of presentations in terms of scope, detail, and display techniques; (b) public meetings to explain the TSPA-VA process and results, using the presentations found to be effective in the focus groups, to inform and also to obtain feedback; and (c) interactive technology, allowing public access to, and feedback on, different levels of technical information on the World Wide Web.

In addition to these potential new initiatives, several activities are currently in progress that provide for a significant degree of "stakeholder" involvement, if the broader definition of stakeholder given in the 1997 report by the Commission on Risk Assessment and Risk Management is used to include those who have "information and expertise that may be helpful." These current activities include the series of Expert Elicitation that are supporting the definition of uncertainties for TSPA, and the TSPA Peer Review activity which has public meetings at the beginning and end of each of its six-month phases.

In order to ensure that any outreach and stakeholder involvement along the lines of the 1996 report's Appendix B are well planned and properly supported, it will be necessary to bring in appropriate expertise and resources, and to include scientists and engineers whose work is represented in the TSPA, as well as the performance assessment analysts. In addition, it will be necessary to coordinate these types of public information and feedback meetings with any broadly similar activities that may be planned in the future as part of the Department's Environmental Impact Statement development process.

DESIGN RECOMMENDATIONS

Recommendation 6:

The Department should develop and examine alternative concepts to the proposed remote underground repository operations, for example, ventilation of emplacement tunnels and shields for waste packages. Some alternatives should be developed in time for consideration in the viability assessment.

Response:

The reference design that will be used for the VA will consist of the features and concepts that will provide us with a reasonable estimate of repository performance based upon best available scientific, engineering, and cost analyses. As recommended by the Board, alternative concepts in repository design and operations will continue to be identified and may be evaluated at the time of the viability assessment. The reference design will continue to evolve until the license application is submitted based on new site characterization findings, cost considerations, operational considerations, features needed to meet licensing requirements, and technology advances. This evolution will include consideration of alternative concepts.

The current approach for the viability assessment design relies on manned locomotives to transport waste packages from the surface facilities to the entrance of the emplacement drift. A remote system is then used to emplace the waste packages in the emplacement drifts. Ventilation is maintained until the emplacement drift is full, then the drift is closed and ventilation is discontinued.

An example of alternatives to this approach being evaluated is active ventilation of all drifts to keep temperatures at or below equipment operability thresholds. A flow of approximately 5 to 7 m³/s in each drift would be needed to keep the emplacement drift temperature below 50°C. This equates to a total volume requirement of 1,000 to 1,400 m³/s for the system, which is 4-5 times that of the current design capacity. Four additional shafts, two for intake and two for exhaust, would be required to move this flow. Two additional main intake drifts, one on each side, and two additional main exhaust drifts would be needed to move the air through the subsurface, distribute it to the emplacement drifts, and return it to the exhaust shafts. The operational cost of maintaining this level of ventilation for all drifts during the entire pre-closure life of the repository could be significant.

In addition, the potential for providing shielded waste packages and continuous ventilation to allow unrestricted access to the emplacement drifts is being evaluated. The evaluation identified serious concerns regarding the reduced thermal conductivity of the waste package (thereby increasing the fuel temperature and degrading the fuel cladding), the operational impact of handling the heavier, shielded packages, and the increased cost of waste packages (\$100K to \$900K per package depending on shielding type). Additionally, increasing the size of the waste package could require larger emplacement drifts. Furthermore, the current concept of not allowing routine personnel access is expected to allow the facility to operate with lower overall personnel exposures than would a concept involving such access.

Recommendation 7:

The Department should evaluate alternative design assumptions to determine whether enhanced repository performance or improved operations can be achieved cost-effectively.

Response:

The Department agrees that the repository design should be formulated from safety, performance, operational, and cost perspectives, and that the design should not favor one feature over another without consideration of the impacts on public and worker safety and overall system cost-effectiveness. The Department believes that the present repository design is flexible and robust. It is capable of accommodating a wide range of design alternatives that will enhance repository performance or improve operations. For example, according to the Controlled Design Assumptions document (CDA, Rev. 06), the repository design is required to not preclude the addition of backfill to the emplacement drifts, if the decision to do so is made at

some time in the future. A design analysis has been completed that demonstrates the feasibility of backfilling the drifts with the current design. A number of the other design alternatives with the potential for improving performance, such as drip shields, ceramic coatings on the waste packages, and drift liners can be accommodated in the current design without making fundamental changes to the repository design. Other design features that may fundamentally impact the design include the waste package size and use of shielded waste packages. If fundamental modifications to the design are required to effectively accommodate necessary improvements, they will be employed. In summary, we are looking at design alternatives from both a performance and cost-effectiveness standpoint.

Recommendation 8:

The Department should evaluate the use of pre-cast or cast-in-place concrete tunnel liners to achieve adequate long-term tunnel support. The evaluation should consider cost and possible effects on waste isolation.

Response:

The Department is evaluating the use of pre-cast and cast-in-place tunnel liners. The current design strategy regarding ground support in the potential repository is to employ robust, full-liner systems in order to produce long-lived, low-maintenance openings. The main drifts, which will remain accessible throughout the pre-closure period, are planned to incorporate cast-in-place concrete liners. For waste emplacement drifts, where access may be limited, the plan is to use pre-cast concrete liners. Because of uncertainty regarding the amount of geologic mapping that may be required in the emplacement drifts, an option involving a temporary system of bolts and wire mesh followed by cast-in-place lining is being considered. A second issue, the potential for concrete to affect long-term performance, is being addressed by considering a third emplacement drift ground support system option—steel sets with steel lagging. As part of this evaluation of liner options, the cost of each system and the differences in costs are being developed.

The following design and testing efforts either are currently under way or are in the planning stages that address the Board's recommendation.

- The viability assessment repository design activity on ground support evaluating the use of pre-cast, cast-in-place concrete, and steel lining is in progress. The inclusion of all three options in the design analysis will minimize potential design schedule impact if subsequent evaluations indicate that pre-cast liners are not acceptable.
- A series of laboratory tests on the chemistry of concrete has been initiated. These tests, being carried out over approximately six-months, are intended to evaluate the evolution of concrete chemistry over time. The testing is focused on providing information on possible pH changes over time in order to provide input to performance assessment evaluations on the suitability of concrete for use in the emplacement environment. At a minimum, two basic concrete mix designs will be tested. This testing commenced during late Fiscal Year 1997.
- A second concrete testing program is also underway. This program is centered on assessing the effects of sustained, elevated temperatures on concrete mechanical properties. Changes in concrete strength and modulus at elevated temperatures are being observed. Of particular interest in this testing is information on the "creep" of the heated concrete under load. Two mix designs are being evaluated in this program. The tests began in the latter part of Fiscal Year 1997, and the final report is expected in March 1998.

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- A third sequence of tests, still in the preliminary stages of planning, is intended to evaluate the mechanical response of different configurations of joints in pre-cast liner segments. This activity should provide input to liner design, both in the shape of joint areas and in the need for reinforcement in the joint region of pre-cast segments. This testing is currently planned as a Fiscal Year 1998 activity.
 - Future cost estimating activities will include costing both the construction and operation of the subsurface repository. Costs will be developed for all three emplacement drift ground-support options as a part of these estimating activities. These data will be available for use in comparative analyses of the options.
 - The Exploratory Studies Facility Heated Drift Test, currently under construction and scheduled for startup in early Fiscal Year 1998, contains several cast-in-place sections at one end of the heated portion of the test area. The rock mass and concrete liner interaction of these lined sections should provide useful information on liner behavior at elevated temperatures.

Recommendation 9:

Given the inevitable uncertainties about repository performance, more attention to defense-in-depth (multiple, redundant barriers) is needed in the waste package and repository designs. In particular, comprehensive studies of alternative engineered barriers—such as fillers, backfill materials, drip shields, and engineered inverts—should be completed.

Response:

The Department agrees that defense-in-depth should be a cornerstone of the waste package and repository designs. DOE is evaluating design alternatives to ensure the system consists of multiple barriers with diverse properties and failure modes to accommodate a wide range of repository conditions. Defense-in-depth for the engineered barrier system can be provided by preventing conditions promoting releases to the accessible environment, mitigating those conditions, should they occur; and providing multiple barriers against unacceptable releases to the accessible environment.

The present design goals for the engineered barrier system are that it should work in concert with the natural site features, not adversely impact natural barriers, and consist of multiple barriers that can be explained and defended by analysis and testing. The Department's strategy for defense-in-depth includes: (1) identification and characterization of a family of engineered barrier system design features that could be employed in the repository; (2) systematic evaluation of performance of the repository using combinations of the design features; (3) selection of design features, such that multiple sets of features exceed performance requirements; (4) assessment of uncertainties associated with each set of design features and selection of appropriate features for design; and, (5) application of an overall margin of safety and confirmation that expected performance of the selected set of design features is consistent with the selected safety margin.

Studies have been conducted, and further studies are planned to develop information and confidence in the contribution to the defense-in-depth concept of many alternative design features. Design features currently under consideration include relying on fuel cladding as a barrier, galvanic protection of the inner wall of the waste package, ceramic coatings on waste packages, large waste packages, small waste packages, invert additives, backfill, drip shields, drift liners, point loading, line loading, and spent nuclear fuel assembly blending.

Appendix E

Nuclear Waste Technical Review Board Publications

The following publications are available by mail from the Nuclear Waste Technical Review Board or electronically from our Web site at www.nwtrb.gov.

First Report to the U.S. Congress and the U.S. Secretary of Energy. March 1990.

The first report sets the stage for the Board's evaluation of the Department of Energy's (DOE) program to manage the disposal of the nation's spent fuel and high-level waste. The report outlines briefly the legislative history of the nation's spent fuel and high-level waste management program including its legal and regulatory requirements. The Board's evolution is described, along with its protocol, panel breakdown, and reporting requirements. The report identifies major issues based on the Board's panel breakdown, and highlights five cross-cutting issues.

Second Report to the U.S. Congress and the U.S. Secretary of Energy. November 1990.

The Board's second report begins with the background and framework for repository development and then opens areas of inquiry, making 20 specific recommendations concerning tectonic features and processes, geoengineering considerations, the engineered barrier system, transportation and systems, environmental and public health issues, and risk and performance analysis. The report also offers concluding perspectives on DOE progress, the state of Nevada's role, the project's regulatory framework, the nuclear waste negotiator, other oversight agencies, and the Board's future plans.

Third Report to the U.S. Congress and the U.S. Secretary of Energy. May 1991.

The third report briefly describes recent Board activities and congressional testimony. Substantive chapters cover exploratory shaft facility alternatives, repository design, risk-benefit analysis, waste package plans and funding, spent fuel corrosion performance, transportation and systems, environmental program concerns, more on the DOE task force studies on risk and performance assessment, federal quality assurance requirements for the repository program, and the measurement, modeling, and application of radionuclide sorption data. Fifteen specific recommendations are made to the DOE. Background information on the German and Swedish nuclear waste disposal programs is included in Appendix D.

Fourth Report to the U.S. Congress and the U.S. Secretary of Energy. December 1991.

The fourth report provides update on the Board's activities and explores in depth the following areas: exploratory studies facility (ESF) construction; test prioritization; rock mechanics; tectonic features and processes; volcanism; hydrogeology and geochemistry in the unsaturated zone; the engineered barrier system; regulations promulgated by the Environmental Protection Agency, the Nuclear Regulatory Commission (NRC), and the DOE; the DOE

performance assessment program; and quality assurance in the Yucca Mountain project. Ten recommendations are made across these diverse subject areas. Chapter 3 offers insights from the Board's visit with officials from the Canadian nuclear power and spent fuel disposal programs. Background on the Canadian program is in Appendix D.

Fifth Report to the U.S. Congress and the U.S. Secretary of Energy. June 1992.

The Board's fifth report focuses on the cross-cutting issue of thermal loading. It explores thermal-loading strategies (U.S. and others) and the technical issues and uncertainties related to thermal loading. It also details the Board's position on the implications of thermal loading for the U.S. radioactive waste management system. Also included are updates on Board and panel activities during the reporting period. The report offers fifteen recommendations to the DOE on the following subjects: ESF and repository design enhancements, repository sealing, seismic vulnerabilities (vibratory ground motion and fault displacement), the DOE approach to the engineered barrier system, and transportation and systems program status.

Sixth Report to the U.S. Congress and the U.S. Secretary of Energy. December 1992.

The sixth report begins by summarizing recent Board activities, congressional testimony, changes in Board makeup, and the Little Skull Mountain earthquake. Chapter 2 details panel activities and offers seven technical recommendations on the dangers of a schedule-driven program; the need for top-level systems studies; the impact of defense high-level waste; the use of high capacity, self-shielded waste package designs; and the need for prioritization among the numerous studies included in the site-characterization plans. In Chapter 3, the Board offers candid insights to the high-level waste management program in five countries, specifically those areas that might be applicable to the U.S. program, including program size and cost, utility responsibilities, repository construction schedules, and alternative approaches to licensing. Appendix F provides background on the Finnish and Swiss programs.

Special Report to Congress and the Secretary of Energy. March 1993.

The Board's seventh report provides a nontechnical approach for those not familiar with the details of the DOE's high-level nuclear waste management program. It highlights three important policy issues: the program is driven by unrealistic deadlines, there is no integrated waste management plan, and program management needs improvement. The Board makes three specific recommendations: amend the current schedule to include realistic intermediate milestones; develop a comprehensive, well-integrated plan for the overall management of all spent nuclear fuel and high-level defense waste from generation to disposal; and implement an independent evaluation of the Office of Civilian Radioactive Waste Management's organization and management. These recommendations should be implemented without slowing the progress of site-characterization activities at Yucca Mountain.

Underground Exploration and Testing at Yucca Mountain A Report to Congress and the Secretary of Energy. October 1993.

This report (eighth in the NWTRB series) focuses on the exploratory studies facility at Yucca Mountain, Nevada: the conceptual design, planned exploration and testing, and excavation plans and schedules. In addition to a number of detailed recommendations, the Board makes three general recommendations. First, the DOE should develop a comprehensive strategy that integrates exploration and testing priorities with the design and excavation approach for the exploratory facility. Second, underground thermal testing should be resumed as soon as possible. Third, the DOE should establish a geoenvironmental board with expertise in the engineering, construction, and management of large underground projects.

Letter Report to Congress and the Secretary of Energy. February 1994.

This report is issued in letter format due to impending legislative hearings on the Department of Energy's fiscal year 1995 budget and new funding mechanisms sought by the Secretary of Energy. The 8-page report (ninth in the NWTRB series) restates a recommendation made in the Board's Special Report, that an independent review of the Office of Civilian Radioactive Waste Management's management and organizational structure be initiated as soon as possible. Also, it adds two additional recommendations: ensure sufficient and reliable funding for site characterization and performance assessment, whether the program budget remains level or is increased, and build on the Secretary of Energy's new public involvement initiative by expanding current efforts to integrate the views of the various stakeholders during the decision-making process—not afterward.

Report to The U.S. Congress and The Secretary of Energy: January to December 1993. May 1994.

This report summarizes Board activities primarily during 1993. It reviews the nuclear waste disposal programs of Belgium, France, and the United Kingdom; elaborates on the Board's understanding of the radiation protection standards being reviewed by the National Academy of Sciences; and, using "future climates" as an example, examines the DOE's approach to "resolving difficult issues." Recommendations center on the use of a systems approach in all of OCRWM's programs, prioritization of site-suitability activities, appropriate use of total system performance assessment and expert judgment, and the dynamics of the Yucca Mountain ecosystem.

Report to the U.S. Congress and the Secretary of Energy: 1994 Findings and Recommendations. March 1995.

This report summarizes Board activities during 1994. It covers aspects of the DOE's Program Approach, their emerging waste isolation strategy, and their transportation program. It also explores the Board's views on minimum exploratory requirements and thermal-loading issues. The report

focuses a chapter on the lessons that have been learned in site assessment from projects around the world. Another chapter deals with volcanism and resolution of difficult issues. The Board also details its observations from its visit to Japan and the Japanese nuclear waste disposal program. Findings and recommendations in the report centered around structural geology and geoenvironment, hydrogeology and geochemistry, the engineered barrier system, and risk and performance analysis.

Report by letter to the Secretary of Energy and the Congress, December 13, 1995.

This report, in the form of a letter, addresses the DOE's progress in underground exploration with the tunnel boring machine, advances in the development of a waste isolation strategy, new work on engineered barriers, and progress being made in performance assessment.

Disposal and Storage of Spent Nuclear Fuel – Finding the Right Balance. March 1996.

This special report caps more than two years of study and analysis by the Board into the issues surrounding the need for interim storage of commercial spent nuclear fuel and the advisability and timing of the development of a federal centralized storage facility. The Board concludes in the report that the Department of Energy's efforts should remain focused on permanent geologic disposal and the site investigations at Yucca Mountain, Nevada; that planning for a federal centralized spent fuel storage facility and the required transportation infrastructure be begun now, but actual construction delayed until after a site-suitability decision is made about the Yucca Mountain site; that storage should be developed incrementally; that limited, emergency backup storage capacity be authorized at an existing nuclear facility; and that, if the Yucca Mountain site proves unacceptable for repository development, other potential sites for both centralized storage and disposal be considered.

Report to the U.S. Congress and the Secretary of Energy: 1995 Findings and Recommendations. April 1996.

This report summarizes Board activities during 1995. Chapter 1 provides an overview of the Department of Energy high-level waste management program, including highlights, current status, legislative issues, milestones, and recommendations. Chapter 2 reports on Board Panel activities and Chapter 3 provides information on new Board members, meetings attended, interactions with Congress and congressional staff, Board presentations to other organizations, interactions with foreign programs, and a review of the Board's report on interim storage of spent nuclear fuel. Appendices include Board testimony and statements before Congress, Board correspondence of note, and the Department of Energy's responses to recommendations in previous Board reports.

Nuclear Waste Management in the United States – The Board's Perspective. June 1996.

This publication was developed from remarks made by Dr. John Cantlon, Chairman of the Nuclear Waste Technical Review Board, at Topseal '96, an international conference on nuclear waste management and disposal. The meeting was sponsored by the Swedish Nuclear Fuel and Waste Management Company (SKB) and the European Nuclear Society. The publication highlights the Board's views on the status of the U.S. program for management and disposal of commercial spent nuclear fuel and provides a brief overview of the program's organization. It summarizes the DOE's efforts to characterize the Yucca Mountain site and to develop a waste isolation strategy for the site. The publication also outlines legislative and regulatory changes under consideration at that time and the Board's views on the technical implications of those possible changes.

Report to the U.S. Congress and the Secretary of Energy: January to December 1996. March 1997.

This report summarizes Board activities during 1996. Chapter 1 provides an overview of the Department of Energy's high-level nuclear waste management program from the Board's perspective, including the viability assessment, program status, and progress in exploration and testing. The chapter ends with conclusions and recommendations. Chapter 2 examines the three technical issues—hydrology, radionuclide transport, and performance assessment—and provides conclusions and recommendations. Chapter 3 deals with design, including the concept for underground operations, repository layout and design alternatives, construction planning, thermal loading, and engineered barriers. The Board also makes conclusions and recommendations. Chapter 4 provides an overview of recent Board activities, including the international exchange of information, the Board's visit to the River Mountains tunnel, and a presentation to the Nuclear Regulatory Commission. Appendices include information on Board members, the organization of the Board's panels, meetings held in 1996 and scheduled for 1997, the DOE's responses to previous Board recommendations, a list of Board publications, references for the report, and a glossary of technical terms.

Report by letter to the Secretary of Energy and the Congress, December 23, 1997.

This report, in the form of a letter, addresses several key issues, including the DOE's viability assessment of the Yucca Mountain site, design of the potential repository and waste package, the total system performance assessment, and the enhanced characterization of the repository block (east-west crossing).