NWTRB Special Report

to Congress and the Secretary of Energy

Nuclear Waste Technical Review Board
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Nuclear Waste Technical Review Board

Table of Contents

Executive Summary

Ten years have passed since the enactment of the Nuclear Waste Policy Act of 1982. During that time, the Department of Energy's (DOE) Office of Civilian Radioactive Waste Management has been developing a system to manage the disposal of spent fuel from the nation's 108 commercial nuclear reactors along with some defense high-level waste. The DOE currently is characterizing a site at Yucca Mountain, Nevada, to determine its suitability for construction of a permanent radioactive waste repository. Surface-based testing at the site is well under way; underground exploration, although delayed for the past three years, is slated to begin in 1994.

Based on its evaluation of the technical aspects of the program, the Nuclear Waste Technical Review Board (the Board) believes that three critical concerns should be addressed to increase the integrity of the scientific and technical program and to improve program effectiveness.

First, the DOE's program is being driven by unrealistic deadlines to begin federal acceptance of spent fuel from utilities in 1998 and to commence repository operations in 2010. The repository development schedule does not reflect a realistic assessment of the technical requirements and nontechnical considerations associated with the development of a geologic repository. The Board is concerned that attempting to meet unrealistic long-term deadlines may force the DOE to make important technical decisions without first performing the appropriate technical and scientific analyses. This could lead to mistakes and costly remediation or potential licensing problems. The Board believes that schedules should be based on realistic target dates for achieving important *interim* goals, such as getting underground, completing critical testing, and determining site suitability.

Second, existing DOE plans for managing spent fuel and high-level waste are not well integrated and contain significant gaps. In developing its plans, the DOE has not considered sufficiently the interdependent nature of storage, transport, and disposal of the waste. Consequently, some important decisions may be made without an adequate technical evaluation of their implications for other components of the waste management system. The Board believes that the DOE should place a high priority on developing a comprehensive, well-integrated plan for the overall management of *all* spent fuel and high-level defense waste from generation to disposal. This plan should be based on a systematic assessment of options related to storage, transport, and disposal.

Third, the large number of organizations involved in the implementation of the U.S. program and the diffuse nature of its organizational structure create substantial challenges for program managers. As a result, management problems seem to be affecting some critical technical aspects of the program adversely. The

Board believes that an independent evaluation of the Office of Civilian Radioactive Waste Management's organization and management should be undertaken. Taking a look at approaches used in other countries could be helpful in such an evaluation.

As the new Secretary of Energy assumes her duties and the 103rd Congress begins its work, the opportunity exists to creatively evaluate the status of this important program. The Board believes that any needed changes to the program can and should be accomplished without slowing the progress of important site-characterization activities at Yucca Mountain.

Introduction

The Nuclear Waste Technical Review Board (the Board) was created by Congress in 1987 to review the scientific and technical validity of the Department of Energy's (DOE) civilian radioactive waste management program. The goal of the DOE's program is to design and develop a system to manage and safely dispose of the spent nuclear fuel being produced at the nation's 108 commercial nuclear power plants[1] along with some high-level reprocessing wastes from defense-related activities.

During its review of the program, the Board has witnessed considerable progress, especially in site characterization and data collection at Yucca Mountain, and, given existing data, there appear to be no scientific or technical reasons to reject the site at this time. In general, the Board believes that individuals working on the program — mostly scientists and engineers — are enthusiastic and very competent in their fields.

However, designing and implementing a nationwide high-level radioactive waste management system is a uniquely challenging undertaking. For example, a disposal system for spent fuel has never been developed before, and the regulations require that after disposal the waste will not pose a threat to human health and the environment for the next 10,000 years. As a result, there are many different, sometimes conflicting, views about the scientific, organizational, and public policy issues facing the civilian radioactive waste management program. Furthermore, questions persist among the public about all things nuclear and about the DOE's ability to manage radioactive waste.

This *NWTRB Special Report to Congress and the Secretary of Energy* briefly outlines three of the Board's major concerns: (1) the program's unrealistic deadlines, (2) the need for an integrated overall waste management plan, and (3) the effectiveness of program management. The Board believes that these concerns should be addressed immediately, concurrent with ongoing site-characterization work, to ensure that the program has a strong technical and scientific base and to facilitate program progress.

1 108 units with operating licenses; 8 additional units have been granted construction permits (USCEA 1993).

Spent Fuel and Defense High-Level Waste Management — Evolution of the Current Program

The safe disposal of the country's spent fuel and high-level defense wastes is an issue of long-standing importance. In 1957, the National Academy of Sciences first examined nuclear waste disposal and recommended permanent burial of the waste in underground repositories (NAS 1957). The Board concurs with current worldwide scientific consensus that no technical or scientific factors appear to exist that would prevent the development of a safe underground repository for high-level waste *at a suitable site.*

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Before a judgment can be made about a given site's suitability or final decisions made about components of a radioactive waste management system, extensive surface-based testing and underground excavation and testing must be undertaken and the resulting data carefully analyzed. Presently, the DOE is carrying out surface-based testing at a site at Yucca Mountain, Nevada, as part of a site-characterization program to determine its suitability for a radioactive waste repository. The DOE plans to begin construction of an underground exploratory studies facility using tunnel boring machines in March 1994. Preparation of the tunnel entrance and construction of support facilities for tunnel boring are presently under way at the site.

The selection of Yucca Mountain, Nevada, evolved from a series of scientific, budgetary, and political considerations. In 1982, after the DOE and its predecessor agencies had tried for more than a decade to find a potential repository site, Congress passed the Nuclear Waste Policy Act, which established a process for evaluating sites for two repositories. A number of potential sites were being studied in both the eastern and western United States when the Secretary of Energy in 1986 deferred the search for a repository site in the East. Critics contend that because the majority of the nuclear reactors are located in the East, the decision to proceed with a repository in the West placed an unfair burden on that region, where sites in Nevada, Texas, and Washington were being evaluated. Finally, after considering a number of issues, including the expense associated with characterizing three sites, Congress amended the Nuclear Waste Policy Act in 1987, selecting Yucca Mountain, Nevada, as the sole site to be characterized for the possible development of the first high-level radioactive waste repository.

Yucca Mountain is located in southern Nevada, about 100 miles northwest of Las Vegas and adjacent to the Nevada Test Site. The DOE's 1988 baseline repository plan calls for the burial of spent fuel and high-level defense waste in a repository consisting of more than 100 miles of tunnels excavated in rock about 300 meters below the surface of the mountain but well above the water table (DOE 1988). The repository would be sealed approximately 50 years after initial waste emplacement.

Federal standards and regulations (some of which currently are under review) will serve as a basis for determining site suitability and for authorizing construction and licensing operation of the repository if the site proves suitable.

Observations about the DOE's Program

During its detailed review of the DOE's program to manage the nation's civilian spent fuel and high-level defense wastes, the Board has made numerous technical recommendations in six previous reports. The following discussion, however, addresses three concerns the Board believes have major implications for the scientific and technical integrity of the program and for eventual program success.

Unrealistic Deadlines are Driving the Program

Observation 1: The DOE's civilian radioactive waste management program is being driven by unrealistic deadlines to begin federal acceptance of spent fuel from the utilities in 1998 and to commence repository operations in 2010. Repository development schedules do not reflect a realistic assessment of the technical requirements associated with the development of a first-of-a-kind geologic repository. Attempting to meet these unrealistic deadlines may force the DOE to make important technical decisions without first performing the appropriate technical and scientific analyses.

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The Current Schedule

The 1982 Nuclear Waste Policy Act authorized the DOE to enter into contracts with the utilities for the acceptance, transport, and disposal of their spent fuel. According to the Act, federal acceptance of spent fuel for disposal in a repository was to begin by January 31, 1998. In January 1987, realizing that this deadline could not be met, the DOE changed the planned start-up date for repository operations to 2003 (DOE 1987), only to change it again two years later to 2010 (DOE 1989). The Board has examined similar programs in other countries, and the U.S. program is the only one the Board is aware of that has been given a *legislatively* mandated date to begin disposal of spent nuclear fuel (NWTRB December 1992).

Because a repository will not be available by 1998, the DOE has planned to site and construct a centralized interim storage facility to store commercial spent fuel until repository operations can begin. Since 1989, the Secretary of Energy's two primary goals for the program have been to (1) begin receiving spent fuel at a centralized interim storage facility in 1998 and (2) begin repository operations in 2010 (DOE 1989). Congress established the Office of the Nuclear Waste Negotiator in 1987. Since his appointment in 1990, the Negotiator has initiated a voluntary process to find a site for the storage facility. Although the Negotiator

has made some progress and a few interested parties have been identified, it appears that insufficient time remains to find a voluntary host site and construct an interim storage facility to begin spent fuel receipt by 1998.

On December 17, 1992, in a letter to Senator Bennett Johnston, Chairman of the Senate Committee on Energy and Natural Resources, then-Secretary of Energy James Watkins acknowledged that no voluntary site had been identified that would allow the DOE to meet the 1998 deadline and asked Congress to authorize and direct the DOE to select alternative candidate sites for interim storage of spent fuel at federal government sites. Considering initial reactions from potential host states, this option also may prove difficult to implement. It therefore appears unlikely that any centralized interim storage facility will be available to accept spent fuel from the utilities by 1998.

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There May Not Be Time to Complete Essential Testing

The original 1998 date for repository operations had to be changed because it was not based on a realistic assessment of the technical requirements of the program, and, given all of the necessary scientific, regulatory, and institutional activities integral to repository development, it also seems optimistic to assume that a spent fuel repository will be operating by 2010. According to the DOE, to meet the 2010 goal it will be necessary to apply by 2001 to the Nuclear Regulatory Commission for authorization to construct the repository. However, there may not be time to complete essential technical activities before that date.

1. *Exploratory studies facility*. Before filing an application for authorization to construct a repository, it is necessary to demonstrate whether or not the site at Yucca Mountain is suitable for repository development. Suitability cannot be determined, however, until an underground exploratory studies facility is constructed at the site. Scientists will then have direct access to the complex underground geology at Yucca Mountain and can begin some of the testing necessary to evaluate site suitability and predict repository performance. The DOE plans to initiate underground tunneling in March 1994, but testing in the tunnels may not begin until 1996.

2. *Underground testing*. Long-term heating and other underground experiments are needed to provide critical information on the effects of heat from the waste (the thermal load) on the surrounding rocks. This information is crucial for determining site suitability and designing the repository system. The Board is concerned that, since the tests have not been initiated, *there may not be enough time* to complete them by the 2001 deadline. Several DOE contractors have

commented to the Board that some of this testing could require a decade or more. If testing at the repository level does not begin until 1996, only five years remain to collect the data on which to base important licensing and repository design decisions.

3. *Waste package design and development.* The waste package is a key component in the radioactive waste management system. The Board has emphasized the importance of adequately and dependably funding research and development of waste package designs (NWTRB November 1990, May 1991, December 1991, June 1992). Yet the DOE has reduced funding to this program during the last three years, thus delaying important research. Deciding which waste package design is most appropriate requires extensive testing of materials — gathering data on how a variety of materials will hold up over thousands of years under various underground conditions. Under the current schedule, sufficient time may not remain to perform this testing adequately.

... technical activities ... have been postponed repeatedly during the last three years, and future delays cannot be ruled out.

These and other technical activities crucial to gathering the information required to determine site suitability and to make repository design decisions needed for licensing the repository have been postponed repeatedly during the last three years, and future delays cannot be ruled out. As a result, there may not be enough time to do the testing and analyses necessary to support important technical decisions.

Other Factors Could Impede Program Progress

A number of other factors beyond the DOE's control also could contribute significantly to further delays in program progress and affect the current schedule.

1. *Funding uncertainties*. To meet its 2001 deadline, the DOE has said that it will need an average of approximately $600 million per year for the next seven years just for *site-characterization* activities.[2] The DOE has never submitted a request to Congress for funding at this level (GAO December 1992). Current funding for the entire program is approximately half this amount. Given ongoing concerns about the large federal budget deficit, it appears far from certain that the Administration will request, or Congress approve, such increases.[3]

2 Carl Gertz in a presentation to the Nuclear Waste Technical Review Board, January 5-6, 1993.

3 According to an attachment to a January 12, 1993, letter to Senator Bennett Johnston, the DOE recommended to the Office of Management and Budget that the Nuclear Waste Fund be taken off budget.

2. *Changes in radiation safety standards*. In the fall of 1992, Congress passed legislation establishing a three-year process for promulgating a revised radiation safety standard and for subsequently revising the Nuclear Regulatory Commission's current regulations and technical requirements for waste disposal (Congress 1992a). Changes in the current standard or in the Nuclear Regulatory Commission's requirements could affect test plans and also could require changes in the design of the waste package and the repository.

3. *Delays in the legislatively mandated process*. The Nuclear Waste Policy Act requires the program to meet a series of milestones prior to applying for construction authorization, including submission of a final environmental impact statement and subsequent approval of the site by Congress by 2001. However, given the history of opposition to the program in the state of Nevada and the general lack of public confidence in DOE decisions,[4] court challenges and procedural delays are quite likely.

The DOE already seems to have made some important choices based on expediency without first performing a thorough technical analysis ...

4. *Unforeseen problems*. There is no allowance in the current schedule for accommodating unforeseen technical uncertainties or institutional problems that inevitably arise during such first-of-a-kind projects.

Considering past delays and the potential for future delays, the Board seriously doubts that either the 2001 construction application deadline or the 2010 repository operation deadline can be met.

Deadlines May Force Premature Technical Decisions

The Board is especially concerned that attempting to meet current unrealistic deadlines may force the DOE to make important technical decisions without first performing the appropriate technical and scientific analyses. This could lead to mistakes, costly remediation, or licensing problems.

The DOE already seems to have made some important choices based on expediency without first performing a thorough technical analysis of the data or of possible alternatives. An example of this is the DOE's selection of a thermal-

4 See Flynn et al. 1992. In addition, the Secretary of Energy Advisory Board Task Force on Radioactive Waste Management was assigned the task of considering what additional steps the DOE could take to increase public trust and confidence in the DOE's civilian radioactive waste management program. Its draft report was completed in December 1992 (SEAB December 1992).

loading strategy for its baseline plan.[5] In its fifth report, the Board pointed out that there is not an adequate technical basis for the DOE's choice of a thermal-loading strategy. The baseline strategy is consistent with accomplishing two objectives. First, it would allow the DOE to quickly demonstrate a capability to dispose of spent fuel (by 2010) and, second, it would minimize the need for long-term spent fuel storage. Attempting to meet these goals seems to have led program management to select a single baseline thermal-loading strategy without first performing a thorough analysis of alternative, perhaps better, thermal-loading options.

Unrealistic deadlines also are forcing the DOE to undertake activities simultaneously that might better be conducted sequentially. For example, it appears that to meet the 2001 construction application deadline and the 2010 date for repository operation, the DOE has selected 25- to 30-ft tunnels for the exploratory studies facility. Although perhaps appropriate for a repository, they are much larger than the Board believes is necessary for testing for site suitability and performing site characterization (NWTRB December 1991, June 1992).

Excavating such large tunnels may only add to existing concerns that: (1) large investments of time and money are creating institutional momentum that inevitably will lead to the selection of Yucca Mountain regardless of its suitability and (2) with no alternative or back-up site, Yucca Mountain must become the repository. These perceptions tend to undermine the DOE's credibility, which already has suffered as a result of problems associated with the management of radioactive wastes at defense facilities.

Summary

The Board ... fully supports the need for schedules with target dates and interim goals to measure program progress.

The Board understands and fully supports the need for schedules with target dates and interim goals to measure program progress. However, keeping to the current unrealistic deadlines may force premature technical decisions before sufficient data can be gathered and analyses performed to support these decisions. This ultimately may undermine the technical validity of the program *and* delay program progress. It also may further undermine the program's credibility among the technical and lay communities.

The Board supports adopting the approaches of other countries it has visited, where efforts are focused on achieving *interim* technical milestones, and where schedules for repository operation are tentatively set based on a realistic assess-

5 The *thermal loading strategy* is a plan for achieving the desired temperatures within the repository over a chosen time period. To develop a strategy, a number of issues must be considered, such as ageing, waste package design, and repository size and design. (See NWTRB June 1992).

ment of program requirements. Most other countries visited by the Board have set goals for repository operation for 2020 or later. There could be many advantages associated with establishing a new, more flexible long-term schedule that incorporates *firm target dates for interim goals*, such as getting underground, determining site suitability, and completing essential testing. Because decisions made under pressure can lead to mistakes and costly remediation or potential licensing problems, adopting a more realistic schedule may actually speed *real* program progress over the long run.

The Program Needs an Integrated Waste Management Plan

Observation 2: Existing DOE plans for managing spent fuel and high-level waste are not well integrated and contain significant gaps. In developing its plans, the DOE has not considered sufficiently the interdependent nature of the system and subsystem components involved in the transport, storage, and disposal of radioactive waste. Consequently, some crucial decisions may be made without an adequate technical evaluation of their impacts on other system components.

From the time it issued its first report in early 1990, the Board has recommended that the management of spent fuel and high-level waste be viewed as a system of interrelated components. Looking at the generation, storage, transport, and disposal of the waste as a system is essential for several reasons.

1. Decisions made about one component of the waste management system may significantly affect other components, and a choice made in isolation could foreclose alternatives that might later be shown to be better for the system as a whole.

Looking at waste management as a system is the most efficient way to set priorities ...

2. Making decisions without adequately assessing their systemwide consequences could jeopardize the licensing of the proposed repository.

3. Developing program plans based on a sound analysis of the system helps avoid errors that may require costly and time-consuming remediation.

4. Looking at waste management as a system is the most efficient way to set priorities, to determine the logical sequence of activities, to integrate the activities of various entities involved in the program, and to develop contingencies to deal with the many uncertainties associated with this first-of-a-kind program.

Important concerns related to the three main components of the waste management system — storage, transport, and disposal — are discussed below.

Interim Spent Fuel Storage

... substantial amounts of spent fuel will remain in storage at reactor sites for decades.

The DOE's baseline plan for the interim storage of radioactive spent fuel requires constructing a centralized interim storage facility in time to begin accepting spent fuel from the utilities by January 31, 1998. Currently, there are approximately 25,000 metric tons of spent fuel stored at reactor sites around the country,[6] and this amount is being added to at the rate of about 2,000 metric tons per year. Under existing law, the capacity of the interim storage facility is limited to only 10,000 metric tons before repository operations begin. Therefore, even if such a centralized interim storage facility and a repository are constructed according to the DOE's schedule, substantial amounts of spent fuel will remain in storage at reactor sites for decades. The implications of extended interim storage have not been addressed in systems planning.

Safely storing spent fuel does not appear to present any serious technical problems. Spent fuel can continue to be stored at the reactor sites in the spent fuel pools (if capacity is available) or in dry casks, as is presently the case at some utilities.[7] The Nuclear Regulatory Commission has determined that spent fuel may be stored safely — wet or dry — for at least 100 years.[8] However, as spent fuel pools near capacity, some utilities have met with resistance in obtaining permits from state and local authorities to use dry cask storage, due in large part to lack of strong evidence that a repository will be available in the foreseeable future.

As discussed in the Board's sixth report, the need for extended interim storage for all of the spent fuel is anticipated in other countries visited by the Board and has been integrated into their waste management plans (NWTRB December 1992). Spent fuel and high-level waste in these countries will continue to be stored at a centralized facility or at reactor sites until final decisions are made about repository development. Because extended interim storage has not been planned for in this country, it is viewed by some as signifying a failure to meet program goals.

In addition to expanding pool and dry cask storage, some nuclear utilities, faced with the prospect of long-term on-site storage, have investigated multipurpose container concepts that could be used to store, transport, and, perhaps, to dispose of the spent fuel.[9] The DOE also is increasing its efforts to develop a

6 By 2030, approximately 87,000 metric tons of spent fuel will have accumulated.

7 Dry cask storage is being used by Virginia Power at its Surry Station, by Duke Power at Oconee, and by Carolina Power and Light at its Robinson Station.

8 This determination is set forth in the Nuclear Regulatory Commission regulation 10 CFR 51.

9 Such concepts have been assessed by others in the past, including the state of Tennessee in the mid-to-late 1980s.

multipurpose container. The state of Nevada has provided important and constructive technical comments on proposed multipurpose container concepts. And the Nuclear Regulatory Commission has been quite positive in its comments about the prospects of licensing such containers. The Board has long advocated the development of alternative container concepts, including the multipurpose container, and is encouraged by these recent developments.

Transport

Spent fuel has been shipped routinely and safely for the past 40 years. However, transport to a repository involves more than shipping. It includes removing the spent fuel from storage at the reactors, loading it into the transport cask, loading and unloading it at points of origin and destination, storing it, and finally placing it in a repository. Once repository operations are under way, the number of annual shipments of spent fuel and high-level radioactive waste will increase dramatically from historic levels. And with the much higher levels of activity and the greater number of people involved, opportunities for human error and equipment failures will increase, and hazards not apparent in the past may become evident. Therefore, measures are needed that will enhance current DOE safety practices. Since its first report, the Board has continued to urge the DOE to incorporate the principles of system safety and human factors engineering into its program to enhance safety performance. The use of a multipurpose container also could help minimize handling and reduce risks associated with transporting radioactive spent fuel.

Disposal

The *thermal-loading strategy* selected for the repository has implications for other components of the waste management system, including the ageing of the spent fuel and the design of both the waste package and the repository.[10] The DOE's baseline plan calls for the disposal of relatively young spent fuel to create above-boiling temperatures within the repository for 300 to 1,000 years, and below-boiling temperatures thereafter. It is not clear that this is the most desirable strategy. In its fifth report, the Board recommended a systematic evaluation of alternative thermal-loading strategies (NWTRB June 1992). Although the DOE

10 Spent fuel assemblies produce substantial amounts of radioactivity and heat (thermal energy) after they are removed from the core of a nuclear reactor. The thermal output of spent fuel decreases significantly over time (especially during the first several decades). Storing spent fuel to reduce its thermal output before disposal (ageing) is one way of controlling or manipulating the thermal load of a repository.

has initiated some work in this area, a comprehensive and systematic analysis of alternative, and potentially better, thermal-loading strategies for the proposed Yucca Mountain site has not been completed. As a result, an adequate technical basis for the DOE's choice of a baseline thermal-loading strategy has not been established. Yet decisions tied to that choice are being or soon may be made about multipurpose container concepts and repository and waste package designs.

... the Board believes an engineered barrier system that includes a robust, long-lived waste package should reduce overall uncertainties about the performance of a repository.

The thermal-loading strategy also has implications for the *engineered barrier system*.[11] Federal licensing standards require the engineered barrier system to work together with the natural barriers to isolate radionuclides from the accessible environment for many thousands of years. Although engineered barriers may have shorter lifetimes than do natural geologic barriers, it will be possible to predict the performance of engineered barriers with greater confidence than is possible for natural barriers. For this reason, no matter where a repository is located and no matter what the geology of the site, the Board believes an engineered barrier system that includes a robust, long-lived waste package should reduce overall uncertainties about the performance of a repository. As indicated previously, the DOE has not given sufficient attention to waste package design.

Other aspects of waste disposal should be more thoroughly evaluated and addressed in a plan to manage *all* high-level radioactive waste. For example, since 1985, federal high-level defense waste disposal policy has been to commingle canisters of solidified high-level defense waste with containers of spent fuel in the same repository.[12] Current estimates of the number of defense waste canisters are very broad — ranging from 15,000 to more than 200,000 — resulting in a more complicated and difficult design process for the disposal system. Other high-level radioactive wastes, such as the Three Mile Island-2 core, spent naval reactor fuel, and other defense reactor spent fuel, will probably require disposal in a repository (NWTRB December 1992). The special problems posed by the disposal of *high-level defense wastes* and *other high-level wastes* should be evaluated and integrated into the DOE's plan.

Another issue that should be considered is how long the spent fuel should remain *retrievable* after it has been placed in the repository. Current indications are that the DOE intends to design the Yucca Mountain repository to meet the

11 The engineered barrier system (in contrast to the natural geologic barrier) is made up of the constructed, or engineered, components of a disposal system designed to prevent the release of radionuclides from the underground facility into the geohydrologic setting. It includes the thermal-loading strategy, repository design, waste form, waste containers, material placed over and around such containers, and backfill material.

12 President Ronald Reagan announced this decision in a memorandum to Secretary of Energy John Herrington, "Disposal of Defense Waste in a Commercial Repository," April 30, 1985.

50-year retrieval requirement.[13] However, a longer retrieval period for spent fuel may offer some advantages, such as being able to monitor waste package performance or recover spent fuel for economic reasons. There also are disadvantages, such as costs associated with monitoring and maintaining the repository. The pros and cons associated with long-term retrievability options should be analyzed thoroughly, before repository design decisions are made.

... the DOE should ... set priorities among the many scientific investigations being planned.

The same principles that are used to evaluate decisions related to the overall system also should be applied to the repository. *Performance assessment* is the primary tool being used to evaluate the safety of waste disposal at Yucca Mountain. It is used to compare predicted repository performance with health and safety standards. Since its first report, the Board has been urging the DOE to begin a process of iterative performance assessment, by which periodic evaluations point out those areas of investigation that need emphasis, to determine site suitability and to ensure safety. In 1992, the DOE completed its first iteration in the performance assessment of the proposed repository at Yucca Mountain. Although additional work may be needed to improve the level of sophistication, the DOE should use this and other similar studies to set priorities among the many scientific investigations being planned.

Summary

The Board has urged the DOE to conduct top-level, systemwide waste management trade-off studies and performance assessment studies while the program is still in its conceptual phase so that decisions made now do not preclude options that may later be shown to be preferable. The management and operations contractor, who was hired to provide program integration, has recently initiated some work in this area. However, as stated in its sixth report, the Board believes that the studies undertaken to date are seriously limited by a number of assumptions being made by the DOE. This will foreclose a serious evaluation of some potentially viable alternatives (NWTRB December 1992).

13 Nuclear Regulatory Commission regulation 10 CFR 60.111.

Program Management Needs Improvement

Observation 3: The large number of organizations involved in the U.S. program and the diffuse nature of its organizational structure create substantial challenges for program managers. As a result, management problems seem to be adversely affecting some critical technical aspects of the program.

The civilian radioactive waste management program encompasses work undertaken by the DOE, its dozen or so private contractors, a number of national laboratories, and the U.S. Geological Survey, as well as many others. The number of people working on the program now totals almost 2,000 (roughly 200 DOE employees and 1,750 contractor employees).[14] The program's organizational structure is multilayered, and the entities are geographically dispersed. Responsibility for decision-making is shared among the program director and associate directors,[15] the management and operations contractor, other private contractors, subcontractors, national laboratories, and the U.S. Geological Survey. Consequently, responsibility for program decision-making seems to be diffuse.

... lack of integration remains a major problem that contributes to inefficiencies in the program ...

The large and unwieldy organizational structure of this DOE program also creates substantial integration problems. The management and operations contractor was hired in 1990 in an effort to consolidate and integrate program activities. However, the management and operations contractor is not being used effectively.[16] Thus, the Board believes that lack of integration remains a major problem that contributes to inefficiencies in the program, especially in the development of a well-integrated waste management plan. This remains a major concern to the Board because, as discussed in the previous section, the lack of a plan affects every aspect of the technical and scientific program.

Another area of Board concern is funding allocation decisions. For example, in fiscal year 1993, funding for overhead and infrastructure — according to the DOE, the basic costs necessary to keep the program operating — will account for approximately 56 percent of total funds for site characterization (Edison Electric

14 In communications with the DOE Office of Civilian Radioactive Waste Management, November 1992.

15 The program has had seven directors in ten years. Five of the seven served in the capacity of acting director.

16 Edison Electric Institute commented in a recent report that the management and operations contractor was being used as if it were "just another contractor." The suggestion was made to allow them to do the job they were hired to do. (Edison Electric Institute 1992).

Allocating such a high proportion of funds to overhead and infrastructure ... may have contributed to delays in the initiation of underground excavation and in the development of a long-lived waste package.

Institute 1992). Allocating such a high proportion of funds to overhead and infrastructure leaves limited funding for important testing and research and may have contributed to delays in the initiation of underground excavation and in the development of a long-lived waste package.

Other countries visited by the Board provide interesting alternatives to the U.S. program's organizational approach. For example, in some countries, a government-sponsored corporation or organization has been created to implement waste management programs. In addition, in most of the countries the Board has visited, spent fuel producers are responsible for safely managing nuclear waste — including, in most cases, planning, financing, and executing all research, interim storage, transportation, and disposal activities. There seems to be more financial and managerial accountability in these countries, and their programs appear to be managed more effectively than the program in the United States (NWTRB December 1992).

Alternatives to the current U.S. organizational and management approach were evaluated in two congressionally mandated studies in the mid-1980s (OTA 1985, Advisory Panel 1984). Since then, no detailed comparison of the U.S approach with alternative approaches has been undertaken. However, Secretary of Energy Hazel O'Leary, at her confirmation hearing in January, indicated that she might undertake an evaluation of the civilian radioactive waste management program. The Board believes that an independent review of the program's organizational structure would be needed and welcome part of that effort.

Summary

The Board believes that the effectiveness of program management and integration needs to be improved and that the program would benefit from a thorough independent review of its organizational structure. Reviewing the approaches being used in other countries could be useful in such a review.

Board Recommendations

Ten years have passed since the enactment of the Nuclear Waste Policy Act of 1982. The Board has concluded from its review of the program that, although significant progress has been made in site characterization and the collection of data at Yucca Mountain, much more remains to be done. Critical interim milestones, such as constructing the underground exploratory studies facility and determining site suitability, have not yet been achieved. There may not be time to complete the testing and analyses necessary to make important repository and waste package design decisions before the 2001 construction application deadline, and circumstances beyond the DOE's control could make it impossible to meet the 2010 deadline for beginning repository operations. Furthermore, the program still lacks a well-integrated overall radioactive waste management plan.

In light of the high cost of the program and the many uncertainties surrounding program progress, it is not surprising to hear public debate escalate over the DOE's radioactive waste management program. In its draft report to then-Secretary of Energy Watkins on January 14, 1993, the Secretary of Energy Advisory Board's Task Force on Radioactive Waste Management recommended measures the DOE might take to strengthen public trust and confidence in the civilian radioactive waste management program. Although somewhat pessimistic about increasing public trust and confidence over the short term, the report does recognize that without a strong technical and scientific program that is based on sound technical analyses, the DOE has little chance of improving public confidence in its radioactive waste management program (SEAB December 1992).

Recent initiatives on the part of the DOE suggest that program managers sense a need for change. In December 1992, the DOE recognized the need to look at alternatives to finding a voluntary host for an interim storage facility. This could result in the serious consideration of a range of options for the interim storage of spent fuel. The DOE also recently announced several new initiatives, including efforts to develop a multipurpose container for the storage of spent fuel and plans to investigate modifications to the existing waste management strategy.[17]

In addition to these new proposals by the DOE, regulatory changes may come about. The federal standards and regulations to be used in siting, constructing, and licensing a repository will be reevaluated in the next few years through a process established in the Energy Policy Act of 1992. Problems with the standards and regulations have been discussed to varying degrees in previous Board reports. Standards and regulations were addressed in more detail in the National Academy of Sciences report *Rethinking High-Level Radioactive Waste Disposal* (NAS 1990).

17 Letters dated December 17, 1992, and January 12, 1993, from the Secretary of Energy James Watkins to Senator Bennett Johnston.

... any program review should be conducted concurrently with ongoing work at Yucca Mountain ...

At her confirmation hearing in January, Secretary O'Leary suggested convening a broad-based group to review the waste management program. The Board supports Secretary O'Leary's suggestion and believes that as she assumes her duties and the 103rd Congress begins its work, a unique opportunity exists to review the program's current status, to evaluate new proposals, and to address concerns about and make needed improvements to the program. The Board believes any program review should be conducted concurrently with ongoing work at Yucca Mountain to ensure that current site-characterization activities continue.

The Nuclear Waste Technical Review Board hopes that the following recommendations will prove helpful to Congress and the Secretary of Energy as they make important decisions about the future direction of the civilian radioactive waste management program.

Amend the Current Schedule

The Board recommends a more flexible schedule for the development of this first-of-a-kind geologic repository. Such a schedule should contain realistic target dates for achieving important interim goals, such as getting underground, determining site suitability, and completing critical testing. The DOE should set testing and funding priorities to achieve these interim goals. Once some of the interim goals have been achieved, it should become easier to realistically predict long-term schedules for repository operation.

Develop a Comprehensive Waste Management Plan

The Board recommends that the DOE place a high priority on developing a comprehensive, well-integrated plan for the management of all spent fuel and high-level waste, including its storage, transport, and disposal. This plan should be based on a systematic assessment of the interdependent nature of the various waste management components. It should include an evaluation of the following:

- a range of options for accomplishing the long-term storage of *all* spent fuel;
- the development of a multipurpose container concept that will help minimize handling of the spent fuel;
- the incorporation of system safety and human factors engineering to enhance the safety performance of the total system;

- the relative trade-offs associated with choosing among the various alternative thermal-loading strategies;
- the potential contribution of engineered barriers, including a robust, long-lived waste package to reduce the uncertainties associated with the long-term performance of the repository;
- the potential impacts of various options for incorporating disposal of other types of wastes into the waste management system; and
- the desirability of maintaining retrievability of the spent fuel beyond the currently projected period of 50 years after initial emplacement.

Review Program Organization and Management

The Board recommends that an independent evaluation of the Office of Civilian Radioactive Waste Management's management and organizational structure be undertaken. Reviewing approaches used in other countries could be useful in such an evaluation.

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