NWTRB Update on Status of Yucca Mountain Studies

Presentation to the U.S. Nuclear Regulatory Commission

June 14, 2001

Dr. Jared L. Cohon, Chairman
Dr. Debra S. Knopman, Member
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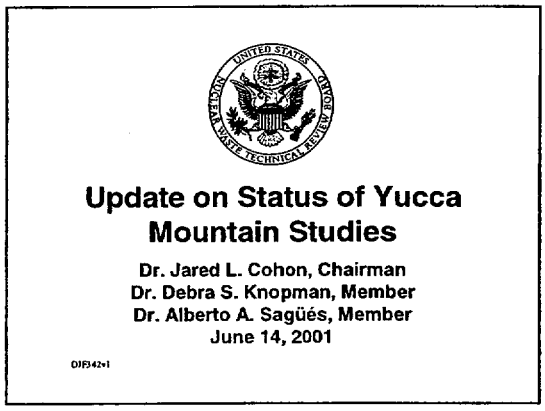
Introduction

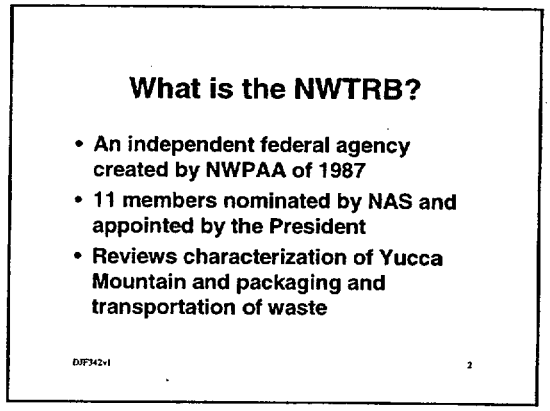


Good afternoon. My name is Jared Cohon. With me today are Debra Knopman and Alberto Sagüés. We are three of eleven members appointed by President Clinton to serve on the U.S. Nuclear Waste Technical Review Board. My full-time job is President of Carnegie Mellon University in Pittsburgh. My expertise is in environmental and water resource systems analysis, and my research interests focus on multiobjective programming, a technique for decision-making in situations with multiple conflicting objectives. When Dr. Knopman is not working on Board matters, she works at her full-time job as senior engineer at RAND Corporation in Arlington, Virginia. Her expertise is in hydrology, environmental and natural resources policy, systems analysis, and public administration. Dr. Sagüés is Distinguished University Professor in the Department of Civil and Environmental Engineering at the University of South Florida. He brings to the Board expertise in corrosion and materials engineering, physical metallurgy, and electrochemical measurements. His research interests are in corrosion and durability forecasting of civil infrastructure.

It's a pleasure for us to be here today to present an overview of the Board's review of the Department of Energy's (DOE) activities related to characterizing the proposed repository site at Yucca Mountain, Nevada. I will begin with some general remarks on the Board, its mandate, important program milestones, and some Board concerns. Then, Drs. Knopman and Sagüés will follow up with specific comments on recent Board activities and on Board comments to the DOE.

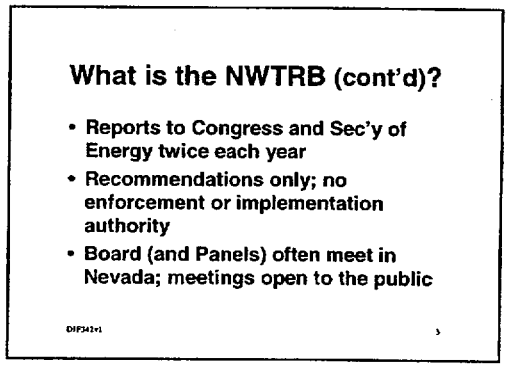
What is the NWTRB?

Let me start by giving you some background on the Nuclear Waste Technical Review Board. The Board is a small independent federal agency created by Congress in the Nuclear Waste Policy Amendments Act of 1987. The Board reports to Congress and makes recommendations to Congress and the Secretary of Energy. Congress charged the Board with evaluating the technical and scientific validity of activities undertaken by the DOE as part of its program to characterize the Yucca Mountain site as the proposed location of a repository for the disposal of nuclear waste. The Board also reviews other DOE waste management activities, including transportation and packaging of spent nuclear fuel and high-level radioactive waste.



Board members are appointed by the President from a list of nominees submitted by the National Academy of Sciences. All the Board members are eminent in a relevant field of science or engineering and are selected solely on the basis of distinguished service. Board members serve on a part-time basis for 4-year terms.

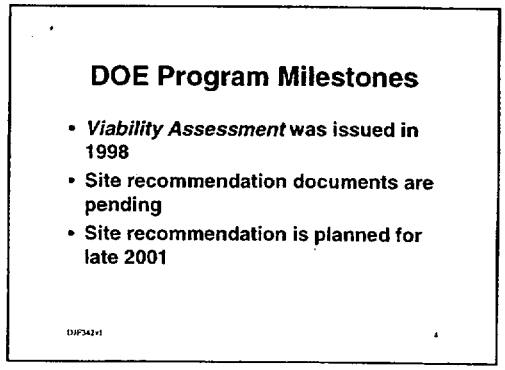
The Board performs ongoing, unbiased technical and scientific review of the DOE program. Congress told the Board to review the work of the Secretary as the work is unfolding so that the Board's recommendations would influence DOE decisions before they are made. The Board also is mandated to report its findings and recommendations to Congress and the Secretary of Energy at least twice each year. The Board's peer-review role in evaluating the characterization of the Yucca Mountain site is different from the regulatory role of the Nuclear Regulatory Commission in licensing a proposed repository. The Board can only make recommendations; it has no implementing authority.



Full Board meetings are open to the public and are held usually in Nevada and occasionally in Washington, D.C. The Board has organized itself into panels that hold meetings on an as-needed basis in locales appropriate to the meeting subject.

Program Milestones

As you know, over the last few years, the intensity and importance of activities related to disposing of and managing spent nuclear fuel and high-level radioactive waste have increased considerably. There are several important program milestones on the path to possible repository development. Some of these milestones, such

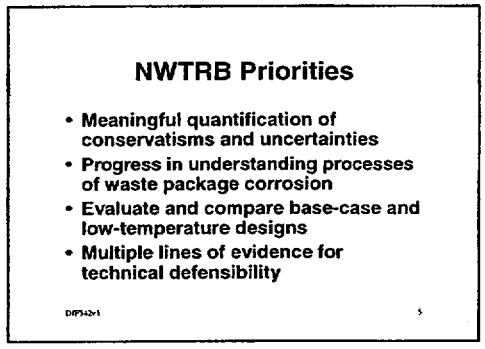


as the issuance of the viability assessment, or VA, and the draft environmental impact statement have passed already. Others, such as the documentation to support a possible site recommendation, are pending, and still others—a site recommendation and a license application—are statutorily established and are conditionally planned by the DOE for the not-too-distant future.

How one views the significance of these program milestones may differ, depending on one's perspective and objectives. To some, the site recommendation may be viewed as a *relatively* important decision on how much money should be spent: Should we spend the money necessary for entering into the licensing process? Others may think that the SR is the most significant of all the decisions, signaling a "go, no go," decision on repository development. How one views these milestones may influence greatly the importance one attaches to them. However they are viewed, one thing that all the milestones have in common is that they will be associated with various levels of uncertainty about long-term repository performance.

Primary Board Concerns

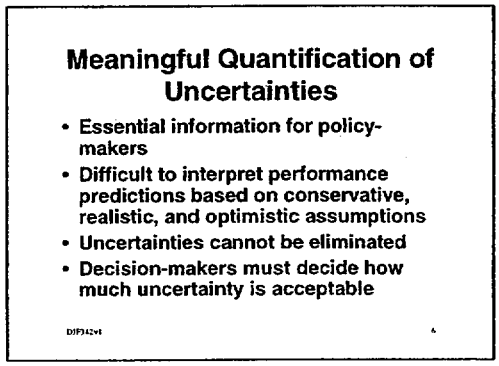
In accordance with its congressional mandate, the Board reviews the DOE's technical and scientific program and makes its technical judgments accordingly. During the past year, the Board identified four priority areas in which additional work is needed. As summarized at the Board's January 2001 meeting in Amargosa Valley, Nevada, the areas are the following:



- meaningful quantification of conservatisms and uncertainties in the DOE's performance assessments
- progress in understanding the underlying fundamental processes involved in predicting the rate of waste package corrosion
- an evaluation and a comparison of the base-case repository design with a low-temperature design
- development of multiple lines of evidence to support the safety case of the proposed repository, the lines of evidence being derived independently of performance assessment and thus not being subject to the limitations of performance assessment.

Meaningful Quantification of Uncertainties

The Board believes that meaningful quantification of the uncertainties associated with estimates of repository performance, presented clearly and understandably, is essential to give policy-makers who are deciding on a site recommendation critical information on trade-offs between projected performance and uncertainty in the projections. The Board made



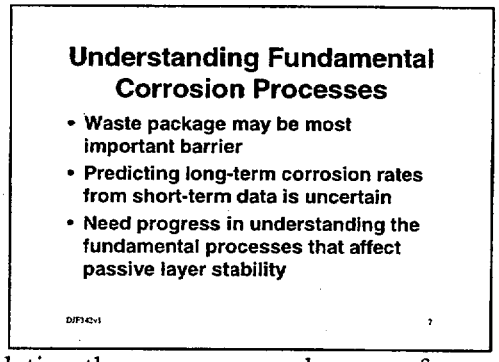
several suggestions in 2000 to assist the DOE in this task. The Board was encouraged by the efforts made by the DOE during the year but also cautions that additional efforts are needed before a case can be made that uncertainties have been estimated in a technically credible manner.

A closely related issue requiring further thought is the adoption of a mix of conservative, realistic, and optimistic assumptions in models and parameters. Determining the overall level of conservatism for a mix of conservative, realistic, and optimistic assumptions will be very difficult. If the DOE wants to argue that a performance assessment is conservative, an effort must be made to provide a defensible estimate of the overall level of conservatism.

The Board realizes that any projection of long-term performance of a potential repository at Yucca Mountain is inherently uncertain. Eliminating all the uncertainties will never be possible (although they can be reduced), and a decision on whether to recommend the site can be made at any time, depending in part on how much uncertainty is acceptable to policy-makers. The Board believes, however, that developing methods for quantifying uncertainties in the DOE's performance assessments should be a priority area of work for the Yucca Mountain Project.

Understanding Fundamental Corrosion Processes

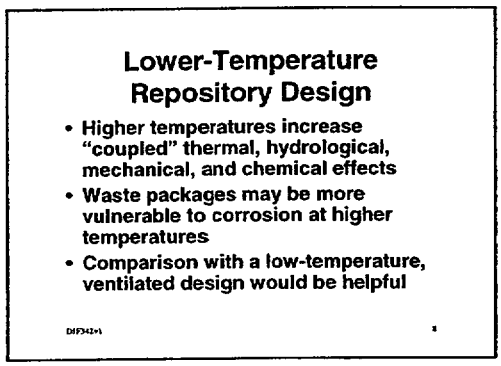
Sensitivity and neutralization studies indicate that the waste package may be the most important barrier for containing and isolating radioactive waste during the proposed 10,000-year regulatory period. Therefore, the data, models, and assumptions pertaining to waste package performance deserve special scrutiny.



There have been significant improvements in waste package data and models since the performance assessment for the DOE's 1998 *Viability Assessment* (DOE 1998). For example, a major advance is the model relating the presence or absence of liquid water on the outer surface of the waste package to relative humidity at temperatures above the boiling point. Similarly, the long-term-corrosion testing facility at Lawrence Livermore National Laboratory has enhanced the data set from which corrosion rates are estimated. Nevertheless, extrapolation of corrosion rates determined from short-term (a few years) experiments to predict waste package performance over tens of thousand of years is a subject of great uncertainty. Long-term extrapolations may be suspect if they are made with little or no understanding of the fundamental mechanisms that affect the passive layer that is critical to the corrosion resistance of Alloy 22. If possible, such understanding should be accompanied by examples of long-term (in a geological sense) protection by passive layers in aggressive environments. There may be passivity deterioration processes not yet observed, but still plausible in such a long time frame, that merit scrutiny. For example, degradation could result from defects encountered by the passive layer as it sweeps into the metal. The long-term effects of accumulation of passive dissolution corrosion products are not known and may be detrimental. Enhanced dissolution akin to transpassive phenomena might develop under certain

circumstances. Progress in understanding the fundamental processes potentially leading to these or other as yet unknown deterioration processes is needed to support long-term predictions of waste package corrosion.

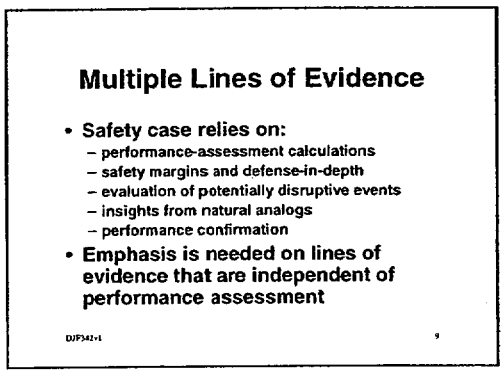
Lower-Temperature Repository Design



Some of the current large uncertainties about waste package and repository performance are directly or indirectly related to the high (above-boiling) repository temperatures associated with the DOE's current base-case design. High temperatures increase the level, extent, and significance of the combined, or "coupled," effects of thermal, hydrologic, mechanical, and chemical processes. Furthermore, the waste packages may be more vulnerable to corrosion at higher temperatures if water is present. The Board believes that it will be very difficult for the DOE to improve substantially its current understanding of these high-temperature effects during the next year or two. However, it may be possible over several months to reduce some uncertainties—for example, by developing a lower-temperature repository design.

The Board is interested in obtaining an evaluation and a comparison of the base-case, high-temperature repository design with a low-temperature, ventilated design. Evaluating a possible low-temperature, ventilated design could clarify the advantages—and disadvantages—associated with keeping waste package temperatures below, say, 85° C. In particular, the Board believes that DOE should use performance assessment to evaluate a low-temperature, ventilated design concept. If necessary, performance assessment models should be modified to portray accurately the effects of temperature changes on performance. Associated levels of uncertainty in repository performance should be developed for both high- and low-temperature design concepts. The Board realizes that DOE also may want to examine other design-related considerations, including licensability, operations and logistics, flexibility, cost, etc. The more technically defensible and quantitative the evaluation and comparison, the more useful it will be for policy-makers.

Multiple Lines of Evidence

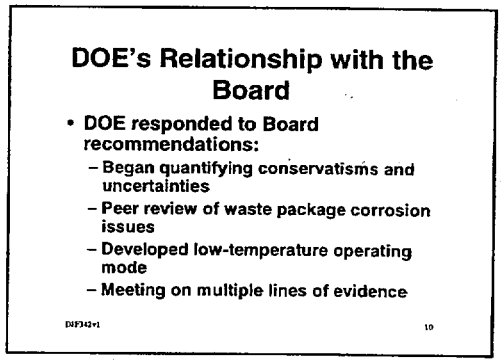


Although demonstrating, in a conventional sense, how a repository will behave thousands of years into the future may not be possible, steps can be taken to increase confidence in estimates of future performance. The Board has strongly endorsed the DOE's efforts to develop multiple lines of evidence supporting a "safety case" for the proposed repository. During 2000, a fourth iteration of *Repository Safety Strategy (RSS)* (CRWMS 2000) was prepared that describes a safety case for a Yucca Mountain repository.

The DOE's safety case rests on key elements, or "pillars": performance-assessment calculations, safety margins and defense-in-depth, evaluation of potentially disruptive events, insights from natural analogs, and performance confirmation. In the Board's view, the pillars of the *RSS* do not yet satisfy the goal of providing multiple lines of evidence and therefore do not substantially increase confidence that a repository at Yucca Mountain will perform as anticipated. Some of the pillars—performance-assessment calculations, safety margins and defense-in-depth, and analyses of disruptive events—as currently presented are all dependent on performance assessment. Thus, if one lacks confidence in the DOE's performance assessment, one is not likely to have much confidence in the other pillars that depend on it. The last two pillars of the repository safety case—natural analogs and performance confirmation—*are* independent of performance-assessment calculations. However, the DOE's evaluation of natural analogs so far has been minimal, and performance confirmation is simply a plan of activities that will be subject to future budget and time constraints. Additional development of multiple lines of evidence supporting the safety case of the proposed repository should be a high priority for the Yucca Mountain Project.

The DOE's Relationship with the Board

The DOE was responsive to the Board's recommendations in 2000, and progress was evident in each of the priority areas identified by the Board.



- The DOE initiated an effort to quantify conservatisms and uncertainties that had not been quantified previously.
- The DOE has initiated an external peer review of waste package corrosion issues and the Board has begun a review of fundamental corrosion mechanisms.
- The DOE developed a low-temperature operating mode for its existing repository design that can maintain repository temperatures below boiling indefinitely. (The Board remains concerned, however, that a comparison of high- and low-temperature designs is needed.)
- Finally, the DOE participated in a Board meeting in April of this year to review multiple lines of evidence for projecting repository performance, including the degree to which such lines of evidence that are independent of performance assessment can be found.

Summary

In conclusion, we emphasize that, at this point, the DOE has not found any characteristics of the Yucca Mountain site that would automatically eliminate it from consideration as the site of a permanent repository for spent nuclear fuel and high-level radioactive waste. However, the long-term performance of a repository—at Yucca Mountain or anywhere else, for that matter—is inherently uncertain. Forthcoming documentation from the DOE may include an improved and

more comprehensive quantification of uncertainty that could help decision-makers as they consider whether to recommend development of a repository at the Yucca Mountain site.

This concludes our prepared presentation. We will be happy to answer any questions you may have.