



UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW
BOARD

2300 Clarendon Boulevard, Suite 1300
Arlington, VA 22201

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Mr. Edward F. Sproat III
Director
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dear Mr. Sproat:

Thank you very much for attending the U.S. Nuclear Waste Technical Review Board meeting in Amargosa Valley, Nevada, on September 27, 2006, at which the Office of Civilian Radioactive Waste Management (OCRWM) presented its safety case for a high-level radioactive waste and spent nuclear fuel repository at Yucca Mountain. Your update on the OCRWM milestones and objectives related to submitting an application to the Nuclear Regulatory Commission for construction of the repository was very informative, as were your comments on what will be needed to begin repository operation in 2017. The Board also appreciated your participation throughout the meeting and hopes that you found the technical exchanges useful.

The Board believes that the information presented by OCRWM at the meeting may indicate an evolving understanding of the importance of a safety case in building confidence in the Department of Energy's estimates of repository performance. However, the presentations also made clear that work remains to be done in developing key elements of a comprehensive safety case. To be credible and effective in supporting the safety case, each element requires conceptual clarity and strong programmatic commitment. Preclosure operations can have significant implications for postclosure performance; therefore, the integration of preclosure activities with postclosure issues, such as repository design and thermal management, requires careful consideration. Some observations on OCRWM's safety case follow.

Key Elements of the Safety Case

An effective safety case should include a total system performance assessment (TSPA) supplemented by additional lines of evidence and argument, including performance-margin analyses, natural analogs, and a well-thought-out performance-confirmation plan.

- TSPA provides quantitative estimates of repository performance that are the core of the safety case. It is the primary tool for analyzing coupled interactions among multiple barriers that affect radionuclide transport, including the engineered barrier system, the unsaturated

zone, and the saturated zone. To increase confidence in repository performance estimates, TSPA should include consideration of all credible and consequential phenomena that significantly affect dose over the period of regulatory compliance. Given the importance of TSPA, the Board is especially interested in the results of new repository system performance assessments and how they affect the repository safety case.

- Assessing the realism of TSPA performance estimates can be challenging because some assumptions may be very conservative while others may be nonconservative. The performance-margin analyses identified at the meeting can be very valuable in assessing the magnitude and effects of conservative and nonconservative aspects of TSPA.
- Natural analogs of many relevant repository phenomena can be used to challenge and evaluate conceptual and numerical models. Analogs that have existed for periods of time commensurate with the regulatory compliance period proposed for the repository provide excellent cases for testing prevailing conceptual and numerical models of radionuclide transport and isolation.
- The purpose of performance confirmation is to critically evaluate analyses and assumptions underlying performance estimates. Thus, the performance-confirmation plan should identify in detail what elements of the performance assessment are to be evaluated, how the elements will be tested or monitored, how information from testing and monitoring will be evaluated, what actions will occur as a result of those evaluations, and how frequently such evaluations will occur.
- Repository design and preclosure operations have significant implications for post-closure repository performance. How decisions related to preclosure operations have been integrated into the postclosure safety case is unclear.

Science and Technology

Over the course of repository licensing, construction, and operation, there will be important opportunities for continuous learning and improvement in scientific and technical areas. For example, as pointed out by your staff, prediction of coupled thermal, hydrological, mechanical, and chemical processes poses significant scientific and technical challenges. Together, these phenomena are the environmental controls on waste package and waste form degradation. Thus, they are significant for radionuclide isolation and migration and for dose levels. Investigations currently supported by the science and technology program have the potential over the long term to improve fundamental understanding in key areas and consequently to improve understanding of the repository's ability to isolate radionuclides. It is important that support for investigations sponsored by the Science, Technology and Management group is sustained and that formal links are established between these efforts and performance-confirmation planning. At the meeting, contractor staff identified a long-term science program, which also can help further the goal of continuous learning and improvement.

Engineering Prototyping

As mentioned at the meeting, the efficacy of engineering designs—including operational processes—can be tested using prototyping. This is especially important in the case of the Yucca Mountain repository because many of the engineered elements are first-of-a-kind designs.

Examples of specific elements that could benefit from engineering prototyping include waste package fabrication, loading, sealing, and emplacement; robotics; and drip-shield emplacement. Experience gained from engineering prototyping will enable OCRWM to identify potentially high-consequence design and operational flaws in an orderly and efficient manner. For example, contemporary industrial experience has shown that metal fabrication defects can be susceptible to localized corrosion. This has important implications for performance of the repository waste packages. Many engineering design specifications are important to TSPA calculations. Consequently, engineering prototyping can serve as an integrating mechanism and a cross-check for TSPA. Finally, engineering prototyping can be helpful as the repository program moves its focus from research and analysis to implementation.

Thank you again for participating in the Board's meeting on the repository safety case. We look forward to additional interactions with you and your Yucca Mountain Project team on this important topic.

Sincerely,

{Signed by B. John Garrick }

B. John Garrick
Chairman