



UNITED STATES  
NUCLEAR WASTE TECHNICAL REVIEW BOARD  
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November 10, 1999

Mr. Lake H. Barrett  
Acting Director  
Office of Civilian Radioactive Waste Management  
U.S. Department of Energy  
1000 Independence Ave.  
RW-2/5A-085  
Washington, DC 20585

Dear Mr. Barrett:

As has become customary, I am writing to give you the Board's reactions to information presented by the DOE at the Board's latest meeting, which was held in Alexandria, Virginia, on September 14-15, 1999.

Board members uniformly feel that the meeting was very productive. This outcome was due, in large part, to the participation by the DOE and its contractors. The Board was pleased with the efforts of your team to develop presentations that addressed specific Board issues and concerns. The presentations were of high quality, well-integrated, and tightly focused. DOE and contractor staff responded to the Board's questions in an open and informative fashion.

The Board encourages the DOE to continue important work in three areas. First, the DOE should complete its latest revision of the repository safety strategy. This document can establish a critical foundation for explaining to both policy-makers and members of the general public how a repository at Yucca Mountain might function, for prioritizing investigations, and for developing a licensing safety case. Second, the DOE should continue pursuing experiments in the east-west cross drift aggressively. These studies can produce important data about seepage into the drifts and flow in the unsaturated zone, variables that strongly influence repository performance. Finally, the Board realizes that the DOE is making progress in evaluating new designs for the waste package and the engineered barrier system. For example, corrosion testing has produced important information about the degradation rates of Alloy 22. This work needs to be sustained into the future because it supports a central premise of the repository safety case.

The Board would like to communicate to the DOE the following specific thoughts about some of the topics that were addressed at the meeting.

### *Repository Safety Strategy*

Previously the Board stated that an appropriate repository safety strategy consists of an assessment of projected repository performance, design margin and defense-in-depth, consideration of disruptive processes and events, insights from natural or man-made analogs, and a performance confirmation plan. The Board is pleased, therefore, that the DOE is revising its repository safety strategy along these lines in light of new information collected and changes in repository design adopted since the viability assessment was completed. In particular, the Board is encouraged by the importance attached to demonstrating defense-in-depth. Barrier importance analysis seems to be a promising vehicle for describing how much defense-in-depth is available within a repository system. The Board, however, believes that this methodology needs to be refined further before valid conclusions can be drawn about defense-in-depth.

According to the presentations at the meeting, the DOE plans to focus on seven “principal factors.” These factors apparently will strongly influence what investigations will be conducted during the next two years. Moreover, these factors apparently will be the key variables for upcoming performance assessments; other, less important, influences on repository performance may be only bounded. Given the importance assigned by the DOE to these factors, it is essential that their selection be based on rigorous technical analyses that are clearly presented and supported with as much empirical data as possible. The DOE also will need to consider carefully whether bounding other, less important, variables is appropriate. Unless the DOE can support its choice of principal factors and its use of bounding analysis, making the repository safety strategy technically persuasive will be difficult.

### *Model Validation*

As DOE's presentations and our subsequent roundtable discussion revealed, the technical defensibility of a mathematical model of complex and only partially observed physical processes can sometimes be a matter of degree. In some situations, however, particularly under conditions beyond those for which calibration data are available, the model's inadequacies may clearly and unequivocally render it invalid. The use to which the model will be put may affect the standard by which technical defensibility is judged. For example, a model like TSPA that is used to guide decision-makers carries a higher burden of defensibility than a model that is used by field investigators to gain detailed process-level understanding and to guide a discrete and limited field sampling program.

On the basis of the DOE presentations, the Board is concerned that significant issues associated with model validation may not be examined adequately by the time the final site recommendation report

is currently scheduled to be sent to the President. Among the questions the Board believes that the DOE needs to address in a technically defensible way are the following.

- Have sufficient data been collected to test and to evaluate adequately alternative process-level models?
- To what extent will multiple and independent lines of evidence, including natural analogs, be marshaled to test a model's validity?
- What will be the basis for judging a model's validity over long periods of time when the model was calibrated using short-term data?
- How will external peer review be used in the validation process?
- How will the validity of the overall performance assessment be judged in relation to the validity of the individual process models?

Answering these questions is admittedly challenging. Nonetheless, the Board feels that providing policy-makers, the technical community, and the general public with well-developed responses to the questions is essential for developing a credible site recommendation report.

### *Treatment of Uncertainty*

As you know, the Board has a long-standing interest in how the DOE analyzes and presents the inherent uncertainty that will surround its performance assessments. The Board realizes that the DOE will have to follow applicable regulations and regulatory guidance when it presents its performance assessment findings in the context of a license application. The DOE has significantly more discretion, however, in how it treats uncertainty in the site recommendation report. In particular, the Board believes that the DOE has an important obligation to present its technical analyses in a way that gives policy-makers in the executive and legislative branches as well as interested members of the general public a clear understanding of the uncertainties involved in projecting the performance of a repository at Yucca Mountain.

The Board will be devoting a significant part of its upcoming meeting in January to how uncertainty can be analyzed and presented. Among the topics that will be considered are the following.

- The different kinds of uncertainty and how they can be treated
- Displaying uncertainty in a manner that best communicates its nature and extent
- Alternative ways of incorporating and considering uncertainty in decision-making.

After the January meeting, the Board will provide you with additional views on the evaluation and description of uncertainty.

### *Modeling Results and Technical Investigations*

The Board wants to comment on two presentations. The presentation dealing with the model of seepage flux into a repository drift concluded tentatively that seepage in drifts constructed in the middle nonlithophysal zone would not occur unless the percolation flux exceeds 1000 mm/year. This conclusion is an extremely important one, but as acknowledged in the technical analysis, it is highly dependent on assumptions about the shape of the drift and about its long-term structural integrity. The Board will be looking closely at this model and will comment in greater detail about its appropriateness for inclusion in forthcoming performance assessments.

The presentation on waste package degradation indicated that valuable information is being collected on Alloy 22 at a rapid pace. However, concern still exists about the effects on corrosion of radiolytic species, including species formed in the vapor phase. Resolving that concern may necessitate additional experimental and theoretical work. In addition, in the last year or two, the project has done a significant amount of work to determine, or at least to bracket, the entire range of chemical compositions and temperatures that could exist in water films on waste package surfaces. It is important that the DOE's suite of corrosion tests continues to be performed in environments that approximate that range. Finally, the information needed to evaluate the adequacy of the new drip shield design is still fragmentary. The DOE has not established the technical foundation for the performance claims it is making for this element of the engineered subsystem.

In closing, I would like to repeat the Board's view that the DOE team's efforts made the Board's September meeting highly productive.

Sincerely,

Jared L. Cohon  
Chairman