UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD
2300 Clarendon Boulevard, Suite 1300
Arlington, VA 22201

March 20, 2000

Dr. Ivan Itkin
Director
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dear Dr. Itkin:

The Nuclear Waste Technical Review Board was established by Congress in 1987 to evaluate the technical and scientific validity of the activities undertaken by the Secretary of Energy to implement the Nuclear Waste Policy Act, as amended.

As the Department of Energy (DOE) approaches the critical milestone of determining the suitability of the Yucca Mountain site, the Board believes that clarity in how the DOE will characterize the performance of a potential Yucca Mountain repository is imperative. The Board believes that meaningful quantification of the uncertainties associated with performance, clearly and understandably presented, is an essential element of performance characterization. The complexity of the repository system and the length of time over which performance must be estimated make uncertainty both large and unavoidable (although perhaps reducible). Especially important in such a situation is that policy-makers and other interested parties understand the uncertainty associated with key decisions.

Over the years, the Board has endorsed the use of performance assessment (PA) as one means of estimating the long-term behavior of a repository for spent nuclear fuel and high-level radioactive waste. In this letter, the Board comments further on the DOE's current and proposed use of PA in the context of the site-suitability decision. In the Board's view, the DOE has not yet developed a consistent and transparent approach to representing the uncertainty in its estimates of long-term repository performance. Moreover, because the uncertainties in PA may be substantial, the Board believes that the DOE should supplement its performance estimates with additional lines of argument and evidence. Because these comments have a direct bearing on the DOE's recently proposed site-suitability guidelines, I am sending a copy of this letter to be included in the rule-making on 10 CFR 963.

*Analysis and Display of Uncertainty in Performance Estimates*

The DOE has conducted four major PA's since 1991. Although each iteration has become more sophisticated and more comprehensive, the results are still associated with a wide range of uncertainties. The uncertainties arise for many reasons, including the following:

- Incomplete information for characterizing the site and its important heterogeneities and for constructing and calibrating process models
- Lack of information on the conceptual validity of the mathematical process models
- Possible errors in extrapolating short-term information on repository subsystems to long-term projections of repository performance
- Effects on repository performance of phenomena and events that are presently not anticipated.

Some of these uncertainties, such as those associated with site heterogeneity, often have been included in past PA's; others, such as those associated with model uncertainty, often have been left out. Of course, the uncertainties associated with unanticipated phenomena cannot be included.

For the PA being prepared for its site recommendation, the DOE is using a methodology in which uncertainties are addressed differently for different input assumptions and parameters. According to presentations made to the Board at its January 2000 meeting, some of these assumptions and parameters will be single-valued conservative estimates, and others will be represented probabilistically. The Board understands the value of using conservative estimates, but it strongly urges the DOE to work with statisticians and other experts to develop coherent and consistent probability statements about projected repository performance based on those conservative estimates.

The Board is concerned that the PA approach now envisioned by the DOE could deprive policy-makers of critical information on possible trade-offs between projected performance and the uncertainty in those projections. For example, one policy-maker might be willing to accept development of a repository that would release half of the permitted dose, with only a 1 in 1,000 chance of exceeding that permitted dose. However, that same policy-maker might decline to develop a repository that is expected to release only a tenth of the permitted dose, but has a 1 in 4 chance of exceeding that permitted dose. Another policy-maker's preferences might be the opposite. Because the uncertainties about repository system performance may be substantial, estimates of uncertainty about doses are at least as important as estimates of performance.

*Importance of Multiple Lines of Argument and Evidence*

As explained in the Board's April 1997 letter commenting on an earlier DOE proposal to revise the site-suitability guidelines, the Board endorsed the use of PA in support of a site-suitability determination. But the Board stated that the DOE should supplement PA with other meaningful approaches, such as a demonstration of defense-in-depth—including multiple and independent barriers—and compliance with a margin of safety. Similarly, in its 1999 report on the DOE's *Viability Assessment*, the Board concluded that PA could be used as the "core analytical tool" for making the safety case for a repository. However, the Board also noted the limits of PA and expressed doubt that relying "solely on [PA] to demonstrate repository safety will ever be possible." Therefore, the Board recommended that additional lines of evidence, such as natural analogs, be used to overcome these limitations.

The DOE has acknowledged the limits of PA in its *Repository Safety Strategy*. The DOE has indicated that it would demonstrate waste isolation by a number of approaches, including

PA, safety margins and defense-in-depth, performance confirmation, consideration of disruptive processes and events, and insights from natural and man-made analogs. These approaches add confidence to the evaluation of the repository system. They help address concerns about uncertainties that are not explicitly incorporated in PA. Given past experiences at Yucca Mountain and the long operating life of the repository, those concerns may be well-founded. Nonetheless, the DOE's draft site-suitability guidelines propose using only PA to determine the suitability of the Yucca Mountain site, leaving unclear how these additional approaches will in fact be used in the context of site suitability.

*Conclusions*

The Board continues to endorse the use of PA, along with other supporting lines of evidence and reasoning, for making a site-suitability determination. At the same time, the Board believes that addressing PA's uncertainties and the sources of these uncertainties as clearly as possible is essential for technical credibility and sound decision-making. Therefore, the Board recommends that the DOE include in its representation of performance uncertainty a description of critical assumptions, an explanation of why particular parameter ranges were chosen, a discussion of possible data limitations, an explanation of the basis and justification for using expert judgments (whether or not they are elicited formally), and an assessment of confidence in the conceptual models used. In addition, the Board recommends that the uncertainties associated with the performance estimates be identified and quantified well enough so that their implications for the performance estimates can be understood. This analysis also would help the DOE demonstrate the safety-margin component of the postclosure safety case described in the latest revision of *Repository Safety Strategy*.

The Board believes that PA should not be used as the sole source of guidance about the features, events, and processes that might affect long-term repository system performance. Multiple lines of argument and evidence—combined with a clear and complete description of uncertainty—will present a much more technically defensible demonstration of repository safety than will any individual component of the safety case. The Board urges the DOE to keep this perspective in mind as the program moves forward.

Sincerely,

Jared L. Cohon
Chairman

cc:
W. Boyle

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