

Questions for the Record
With Answers from the U.S. Nuclear Waste Technical Review Board

Questions from Senator Domenici

1. **The Nuclear Waste Technical Review Board has, on many occasions, pressed DOE to better address uncertainties in its long term analysis of Yucca Mountain.**

Answer: Over the years, the Board has acknowledged that uncertainties in predicting repository performance are inevitable because of the first-of-a-kind nature of the endeavor, the complexity of the site geology, the implications of high temperatures from radioactive decay of spent nuclear fuel and high-level radioactive waste, and the long timeframes involved. The Board also has indicated the need for understanding better the potential behavior of the repository system and for the Department of Energy to (DOE) to supplement its understanding with additional lines of evidence.

DOE uses a probabilistic approach in estimating repository performance that incorporates uncertainties and sensitivity analyses in its performance assessments. However, the Board is not yet convinced that the assessments are realistic. The Board has asked for a realistic analysis of repository performance so that it can judge the extent of conservatism and uncertainty in DOE's total system performance assessment (TSPA). In addition, the Board has recommended that DOE make its uncertainty analyses more transparent to better expose specific contributions to uncertainty, such as the effect on performance of localized corrosion of the waste packages.

2. **You have not seen the final license application, but, in your opinion, what are the greatest uncertainties with the application? Are these the result of the quality or absence of data, or the fundamental difficulty in predicting the behavior of the mountain over these incredibly long time periods?**

Answer: The Board evaluates the technical validity of work undertaken by DOE. On the basis of that evaluation, the Board's view is that the most important technical and scientific uncertainties related to the postclosure performance of the repository are the release rate and chemical form of dose-contributing radionuclides leaving the engineered barrier system, the extent to which components of the natural system contribute to waste isolation, and the implications of high temperatures for repository performance, including the potential for localized corrosion of the waste packages.

There also are logistical and practical challenges, as well as temperature considerations, associated with preclosure activities, including implementation of DOE's transportation, aging, and disposal canister concept; designs for repository surface facilities; and operational plans.

More data could help address some of these uncertainties. It is important to note that new information may show that the various repository components perform better or less well than currently projected. Either way, performance estimates would be more realistic and therefore would engender more confidence. Estimating repository performance over long time periods can be a challenge. However, as the National Academy of Sciences pointed out in its report, *Technical Bases for Yucca Mountain Standards*, some uncertainties would increase over time and others would decrease. The key is to manage uncertainty so that it does not significantly affect the performance of the repository.

3. Given these uncertainties, do you believe it is more likely that DOE's analysis over or under estimates radiation exposures in the distant future?

Answer: DOE uses TSPA as a tool for estimating whether a Yucca Mountain repository would comply with the regulatory standard. DOE believes that the performance estimates in its TSPA are conservative (i.e., that they underestimate how well Yucca Mountain would perform). The Board believes that the assumptions underlying DOE's performance estimates are a mix—most are conservative, others are realistic, and a few may be optimistic. Although this makes it difficult to assess just how conservative DOE's repository performance estimates are overall, the Board believes that the results taken as a whole may be shown to be conservative. The Board has urged DOE to develop a realistic performance analysis so that important information on this question can be provided to the public, decision-makers, and other affected parties.

4. Can you tell us how the risks of disposing of used nuclear fuel in Yucca Mountain compare to the risks of leaving the material where it is for thousands of years?

Answer: It is the opinion of the Board that storing spent nuclear fuel at existing sites for thousands of years is not a desirable option when compared with permanent deep geologic disposal. Although temporary storage can be accomplished safely for decades, storing the waste indefinitely at reactor sites would require storage facilities to be monitored and maintained constantly and would require periodic replacement as facilities and components degrade with age. If those activities are not carried out faithfully for very long periods, the resulting risks to health and the environment could be significant. Having to manage a large number of high-level-waste sites also raises security issues. Disposing of spent nuclear fuel and high-level radioactive waste in a deep geologic repository would eliminate these concerns.

Questions from Senator Craig

1. **Does the Board believe that there are outstanding scientific or technical issues so serious as to prevent the DOE from submitting a license application?**

Answer: The Board has not explicitly addressed the question of what constitutes a reasonable basis for a license application. The Board's focus is on the soundness of the science and engineering supporting DOE's assessment of the performance of the total waste management system, including preclosure and postclosure activities.

On the basis of its ongoing technical and scientific evaluation, the Board's view is that the most important technical and scientific uncertainties related to the postclosure performance of the repository are the release rate and chemical form of dose-contributing radionuclides leaving the engineered barrier system, the extent to which components of the natural system contribute to waste isolation, and the implications of high temperatures for repository performance, including the potential for localized corrosion of the waste packages. In addition, although DOE's new canister-based concept for transportation, disposal, and aging of spent nuclear fuel may have potential to reduce handling of the waste, the Board wants to understand better the feasibility of the concept, given the status of spent nuclear fuel in storage at utilities and postclosure temperature limits on the waste packages.

The Board has stated that resolving these issues appears "doable," provided that selected analyses and investigations are made to confirm the performance and operation of the repository. Furthermore, resolving all the issues before submitting a license application may not be necessary. However, addressing the issues might substantially increase confidence in DOE's operational plans and estimates of repository performance.

Questions from Senator Bingaman

- 1. You testified that while the DOE has made meaningful progress, serious technical issues remain unresolved. How long, in your opinion, will it take the Department of Energy to resolve those issues and be able to submit a defensible license application to the Nuclear Regulatory Commission?**

Answer: The Board is on record indicating that resolving the issues appears “doable,” provided that selected analyses and investigations are made to confirm the performance and operation of the repository. Some unofficial schedules have indicated that DOE will submit a license application sometime in fiscal year 2008. Although resolving all these issues before submitting a license application may not be necessary, addressing the issues has the potential for substantially increasing confidence in DOE's operational plans and estimates of repository performance. The Board has encouraged DOE to continue its technical and scientific investigations after the submittal of a license application to increase confidence in DOE's estimates of repository performance.

- 2. Does the Board have any reason to believe that Yucca Mountain is not a technically suitable site for the repository?**

Answer: The Board is not aware of any single condition that would automatically make the site unsuitable; however, the engineered components of the repository have to be integrated with the capabilities of the natural system so that they work together to isolate radionuclides. For example, if localized corrosion of the waste packages is shown to occur at high temperatures, it could have implications for repository design and performance. On the other hand, a more realistic model for mobilizing dose-contributing radionuclides following the penetration of the waste packages could reduce uncertainties in the timing and magnitude of the projected peak dose and could enhance the credibility of repository performance calculations.

- 3. As an authority on risk assessment, what is your view of the EPA's proposed radiation protections standards? Specifically—**
 - What is your view of EPA's decision to use a deterministic exposure scenario instead of the probabilistic approach recommended by the National Academy of Sciences?**

Answer: EPA's and NRC's regulation of the program is outside the Board's purview, so I will answer the three questions as they were posed (as the personal opinion of John Garrick).

It is true that the prescriptive features of the regulations with respect to the dose calculations preclude a completely probabilistic or risk-based approach. This is why the Board has repeatedly asked for a realistic—that is, a traditional—“risk assessment” of the repository. I believe, however, that where the regulations are

prescriptive, they are conservatively prescriptive. It should be noted that the EPA's individual protection standard is, to some extent, probabilistic. As the EPA stated when it finalized its revised environmental standards in 2001 (66 FR 32125), "By specifying the mean as the performance measure and probability limits for the processes and events to be considered (§197.36), and in concert with the intent of our 'reasonable expectation' approach in general, we have implied that probabilistic approaches for the disposal system performance assessments are expected."

- **What is the difference between the probabilistic and deterministic approaches?**

Answer: Deterministic approaches are scenario-based and rely on single-valued choices of models and sets of parameters to estimate performance. Probabilistic approaches incorporate the likelihood that each of these and alternative models and sets of parameters are appropriate. The major advantage of a probabilistic approach is the ability to explicitly incorporate uncertainties and variabilities in the analyses. An analysis that incorporates uncertainties is essential to understanding risk.

- **How does EPA's 350 millirem standard between 10,000 and 1,000,000 years compare with other radiation protection standards adopted in this and other countries?**

Answer: The Board is not aware of any countries that require a quantitative risk assessment to be carried out to the time of peak dose or one million years; typical periods for numerical analyses are on the order of 10,000 years. For today's activities and facilities, the International Commission on Radiological Protection and the National Council on Radiation Protection and Measurements both have recommended that radiation exposures to members of the public be limited to 100 mrem/yr from all sources (excluding medical and natural background). My personal opinion is that the EPA standard is reasonable.