



U.S. Nuclear Waste Technical Review Board

TECHNICAL ADVANCEMENTS AND ISSUES ASSOCIATED WITH PERMANENT DISPOSAL OF HIGH-ACTIVITY WASTES

The U.S. Nuclear Waste Technical Review Board was created by Congress in the 1987 amendments to the Nuclear Waste Policy Act (NWPA) and charged with evaluating the technical and scientific validity of U.S. Department of Energy (DOE) work related to implementing the NWPA. An important part of the Board's mission is advising Congress and the Secretary of Energy on technical issues related to managing and disposing of high-activity waste. Regardless of the outcome of deliberations over a Yucca Mountain repository, the Board believes that it is important to extract knowledge while it is still available from the experiences of the Yucca Mountain program and other nuclear waste management programs. The purpose of the report, then, is not to assess the licenseability of a Yucca Mountain repository, it is to identify some of the technical "lessons" that can be learned from the Yucca Mountain experience, to date, and from the experiences of programs in other countries that may be useful to future U.S. programs for waste management and waste disposal.

Long-Term Management of High-Activity Waste—Technical Challenges

Managing high-activity waste is a problem that is neither unsolvable nor trivial. A repository for permanent disposal will be necessary under any scenario, because all nuclear fuel cycles generate long-lived radioactive wastes that cannot be completely destroyed. An international consensus has emerged that burial of this high-activity waste in a deep geologic repository is technically feasible and that such an approach can provide adequate protection to humans and the environment. At least at this time, the only potential alternative to deep geologic disposal of high-activity waste is partitioning the material and transmuting it in reactors or accelerators.

The overarching complication of all high-activity waste-management programs is the long-lived toxicity of the waste, which requires isolating it from biological systems, especially human beings, for many hundreds of thousands of years. The very long half-lives of many of these species present major challenges to demonstrating waste isolation and containment.

Lessons Learned From Yucca Mountain and Other Programs

- *Consideration should be given to specialized deep geologic disposal methods that take advantage of differences in chemical and physical properties of wastes produced by defense, commercial, or reprocessing activities. One possible scenario is using mined geologic repositories for disposing of potentially recyclable spent nuclear fuel, which can be retrieved if necessary, and using deep boreholes for disposing of vitrified high-level waste, which is unlikely to be retrieved.*

- *Programs both inside and outside the United States have provided considerable evidence that many geologic options can be attractive candidates for a repository, including intrusive or extrusive igneous rocks (e.g., granite, tuff) and sedimentary rocks (e.g., salt, clay).*
- *Research conducted over several decades indicates that engineered barriers can delay for extended periods, possibly for hundreds of thousands of years, dependence on the waste-isolation capability of the natural system. Such delay would very significantly reduce the radiotoxicity and simplify the chemistry of waste that might enter the natural system, thus enhancing confidence in estimates of the long-term performance of a repository.*
- *A critical factor in assessing the performance of a geologic repository, and thus the achievement of an efficient design, is quantifying the radionuclide source term entering the undisturbed natural system. Experience indicates an imbalance in the relative emphasis on research on degradation of the engineered barriers and on research related to mobilization of the waste.*
- *There is strong evidence that adopting a total integrated systems approach to performing necessary science, engineering, and construction activities could have improved the implementation of the Yucca Mountain program. A critically important element of such an approach is making the right decisions on transitioning from a science program to an engineering program that involves prototyping first-of-a-kind systems.*
- *The Yucca Mountain program has produced the most comprehensive, internationally peer-reviewed, repository performance assessment covering a million-year timeframe. More generally, probabilistic performance assessments can provide a balanced assessment of contributors to risk and therefore should be used throughout the life of a program to guide the selection of a research portfolio.*

Moving Forward

The experience gained in characterizing various geologic media at Yucca Mountain and around the world has established a very strong technical basis for moving forward with geologic disposal in the United States. All steps necessary to preserve the technical experience base from the Yucca Mountain program should be taken so that it remains readily available and accessible.

Forging and maintaining strong bonds with programs of other countries for managing and disposing of waste also are very important. The diversity of geology being considered worldwide is especially significant to the decision-making of the United States on future programs, because experience strongly suggests that repositories can be developed in many geologic media. Implementers of U.S. repository efforts should consider the site-selection experience of advanced programs as well as the activities of other nations currently selecting sites. Deciding factors for site selection may well be nontechnical.

The Board believes that keeping a focus on a permanent solution is critical regardless of what interim measures for managing high-activity waste are charted. Among the reasons are: (1) a permanent solution is needed under all foreseeable circumstances; (2) a permanent solution is critical to building public confidence that there is a way of isolating nuclear waste radioactivity from the biosphere to acceptable levels; (3) undue delay in implementing a permanent solution could make tenuous a concept of waste management dependent on institutional stability; and (4) experience indicates that deploying a permanent solution to isolating high-activity waste could take decades.