UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

October 31, 1997

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Jackson:

SUBJECT: RECOMMENDATIONS REGARDING THE IMPLEMENTATION OF THE DEFENSE-IN-DEPTH CONCEPT IN THE REVISED 10 CFR PART 60

This letter communicates the recommendations of the Advisory Committee on Nuclear Waste (ACNW) for adopting a revised approach to the existing subsystem performance criteria in 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," to implement the defense-in-depth (DID) concept.

RECOMMENDATIONS

1. The Committee endorses the concept of defense in depth, including institutional as well as structural aspects. In particular, we recognize the benefit of multiple barriers of protection. The Committee recommends that sound principles be set forth guiding the implementation of the concept of defense in depth. The Committee, however, does not endorse the establishment of rule-based subsystem requirements as exist in 10 CFR Part 60.

   We believe that guidance will depend to a large extent on proper construction of a performance assessment (PA) to expose the role of design elements, operational elements, and multiple barriers, including interdependency of the multiple barriers. The regulations should be clear on how the DID concept should be implemented. The Department of Energy (DOE) (or any future license applicant) should be directed to furnish documentation that shows how the DID concept has been implemented in meeting the overall performance goal.

2. The Committee recommends that NRC performance assessment procedures be structured so that the effectiveness of individual barriers can be identified explicitly in the total system performance.

   The PA should clearly expose the effectiveness and role of selected individual barriers such as the engineered systems and the natural geological setting. The assessment of individual barriers should include a quantification of the uncertainties involved and the inter-relationships among barriers. The Committee believes that there are methods for quantifying the role of individual engineered barriers and the containment capability of the natural setting. To achieve the capability to assess the effectiveness of individual barriers, both geological

and engineered, it may be necessary to modify the analysis methods, including the PA models, and to enhance the database to reveal the performance of individual barriers. The Committee also believes that exposure of the public to a PA process that is sufficiently transparent could lead to improved public confidence in the ability of the repository to isolate waste effectively.

This letter is one in a series of letters to the Commission conveying the ACNW's views on aspects of the NRC staff's strategy for revising 10 CFR Part 60. Previous letters on the staff's strategy for revising 10 CFR Part 60 include "Issues and NRC Activities Associated with the National Research Council's Report, 'Technical Bases for Yucca Mountain Standards,' " February 9, 1996; "Time Span for Compliance of the Proposed High-Level Waste Repository at Yucca Mountain, Nevada," June 7, 1996; and the "Reference Biosphere and Critical Group Issues and Their Application to the Proposed HLW Repository at Yucca Mountain, Nevada," April 3, 1997. Our recommendations are formulated on the basis of presentations made to the Committee during the 90th, 91st, 92nd, and 93rd meetings by the NRC staff, the DOE staff and its contractors, the State of Nevada, the National Research Council, and representatives from industry, as well as on the basis of the Commission's policy on risk-informed, performance-based regulation.

The Nuclear Waste Policy Act of 1982, as amended, mandates NRC to develop technical criteria for HLW disposal that are consistent with the Environmental Protection Agency (EPA) generic standards and provide for a system of multiple barriers. The Energy Policy Act of 1992 mandates that NRC conform its regulation to the final EPA standards for Yucca Mountain, the latter of which are to be based on and consistent with recommendations made by the National Academy of Sciences' Committee on Technical Bases for Yucca Mountain Standards (TBYMS). As directed by the Commission, the NRC staff is currently pursuing development of site-specific regulations for Yucca Mountain to implement the forthcoming EPA site-specific standards for Yucca Mountain.

In this letter, the concept of DID refers to the methods of design, construction, and operation of a geological repository for HLW in ways that aim to ensure safety in the face of considerable uncertainty in our knowledge of various processes. The implementation of DID in the repository context entails an analysis that exposes the contribution of each design element, each process (or set of processes) in the natural geological setting, and each operational technique to the safety of the repository. The DID concept includes (but is not identical to) the notion of multiple barriers that act to isolate the waste. One of the major issues regarding regulation within the DID framework is whether and how prescriptive requirements (so-called subsystem requirements) should be placed on classes of these barriers. As discussed below, the Committee believes that the adoption of a risk-informed approach eliminates the need for prescriptive subsystem requirements for Yucca Mountain.

The present form of 10 CFR Part 60 partly implements the DID approach by prescribing performance requirements of particular barriers.[1] As noted in the Statement of Considerations to 10 CFR Part 60, in addition to the natural barrier provided by the geological setting, this multiple barrier approach identifies two engineered barriers: the waste package and the underground facility. The Statement of Considerations notes that the multiple barrier concept is implemented by the performance objectives or requirements, as well as by more detailed siting and design criteria. The Committee

[1]Paraphrasing the regulation, the performance requirements specify substantially complete containment of waste packages for 300 to 1,000 years after permanent closure, release rates of radionuclides from the engineered barrier system less than one part in 100,000 per year at 1,000 years after closure, and a prewaste-emplacement groundwater travel time of at least 1,000 years.

recognizes that inclusion of the quantitative subsystem performance requirements in the rule was thought to provide additional confidence to compensate for uncertainties associated with predicting the behavior of a repository over thousands of years and for the general lack of experience and confidence in analyzing repository performance.

The Committee supports the NRC's view expressed in the Statement of Considerations to 10 CFR Part 60 that the performance of the engineered portion of the repository and the geological system must each make a definite contribution to waste isolation. The Committee recognizes the need for reliance on multiple and diverse barriers as part of the DID concept. However, we do not endorse the implementation of the DID concept through inclusion of prescriptive subsystem criteria in the revised 10 CFR Part 60.

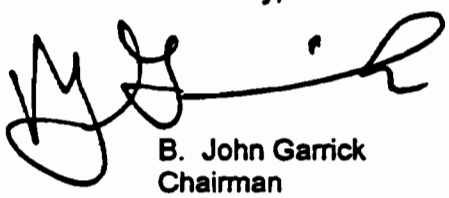
Current thinking, which is supported by much experience and empirical evidence in both probabilistic performance assessment and site characterization is that performance-based regulations are much more efficient and effective in protecting health, safety, and the environment than are "command-and-control" approaches. Focusing on quantitative subsystem requirements for the proposed repository at Yucca Mountain would run counter to this thinking because it potentially could force a design that would increase overall risk even though all subsystem requirements were met. A hypothetical example may clarify: a requirement that backfill in the repository be capable of substantially retaining all radionuclides leached from the waste package for 1000 years might be imposed. Such a requirement, which on the surface could be seen as beneficial, might force a design that would diminish significantly the lifetime of the waste canister by changing geochemical conditions in the near field. The outcome could be an increased risk to affected populations relative to a repository without backfill. It is this type of potentially adverse effect from subsystem requirements that an overall performance-based regulation would avoid. Consideration of such hypothetical examples supports our main conclusion that an overall performance-based regulation in the context of a risk-based standard is a superior tool for promoting safety relative to imposed subsystem requirements.

A major problem with the current version of 10 CFR 60.113, "Performance of Particular Barriers After Permanent Closure," which prescribes performance of particular barriers, is that it is not clear just how relevant any subsystem performance requirement is to the overall safety performance of the repository. Furthermore, in the analysis of repository performance, interdependency of barriers makes it difficult to assess precisely the role of individual barriers. For example, the assumed rate of percolation of water through the repository affects the performance of all subsystems. The connection between barrier performance and overall performance is very site- and design-specific. Prescribing individual barrier performance may create a design that is imbalanced in terms of individual barrier effectiveness. Subsystem requirements may also result in very poor designs from an economic standpoint. The ACNW's view is consistent with the TBYMS report, which cautioned against imposing subsystem requirements that may inadvertently result in a suboptimal repository design.

The primacy of an overall performance-based regulation does not imply that DOE, as the license applicant for Yucca Mountain, would not have to demonstrate convincingly to the NRC that both the geological system and multiple aspects of the engineered system were effective in providing waste isolation capacity. The NRC should insist that the applicant's PA clearly and quantitatively indicates how each barrier contributes to meeting the overall safety objective. This information should provide the basis for an informed decision on the license application.

The approach that we recommend offers many advantages over prescriptive subsystem requirements. First, it allows taking maximum advantage of site- and design-specific properties and features. Second, it is a clear example of risk-informed, performance-based regulation. The important contributors to risk can be ranked, thus providing a basis for prioritizing design changes and risk management activities. Third, it clarifies the degree of dependence of overall repository performance on individual barriers. In a sense, the safety margins of the various barriers are made more explicit through quantification.

Sincerely,



B. John Garrick
Chairman