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

October 8, 1997

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

Dear Chairman Jackson:

SUBJECT: Comments on Performance Assessment Capability in the NRC High-Level Radioactive Waste Program

The purpose of this letter is to advise the Commission about the NRC staff's performance assessment (PA) capability in the High-Level Radioactive Waste (HLW) Program. Performance assessment is an important tool in NRC's prelicensing activities, including the following: understanding the importance of specific site characteristics and the design of engineered features to the performance of an HLW repository at Yucca Mountain, prioritizing key technical issues (KTIs) and staff activities, developing revised standards and regulations for licensing, and preparing for review of the Department of Energy's (DOE's) viability assessment (VA) of the proposed repository. The evaluation of staff HLW PA capability continues to be a priority issue of the Advisory Committee on Nuclear Waste (ACNW).

The observations and comments in this letter have been developed, in part, on the basis of the 93rd ACNW Meeting at the Center for Nuclear Waste Regulatory Analyses (hereafter the Center) in San Antonio, Texas, on July 23-24, 1997. The ACNW previously reviewed and commented on staff HLW PA capability in letters dated December 2, 1991, and May 27, 1994.

Recommendations

The Committee makes the following recommendations:

- Selected capabilities should be added to the program to provide further assurance that the staff has the ability to assess the containment capacity of the engineered systems. Support for KTIs relating to the near-field performance of the repository should be restored. Among the disciplines for which the ACNW believes added capability is necessary are engineering analysis, materials science, and chemistry. The crosscutting discipline of corrosion science and engineering is also an essential part of the mix.

- The PA models should be structured to represent repository performance as realistically as possible and thereby provide the necessary information for regulators to make decisions in the context of the full state of knowledge about the performance measures of the repository. Improved coordination and communication between the NRC staff and the Center will be essential.

- Greater emphasis should be given to collecting, organizing, and documenting the supporting evidence for the performance assessments to enhance acceptance of the results. An important element of this is improvement in communicating the abstraction of process models into probabilistic models. Of particular interest to the Committee is visibility of the treatment of such phenomena as chemical and geological processes leading to the mobilization of radionuclides in the near field.

- A working version of the NRC's Total Performance Assessment code, version 3.1 (TPA-3) should be implemented as soon as practicable.

- A program for verifying TPA-3 should be developed. TPA-3 should be benchmarked against other codes for Yucca Mountain. The Committee also encourages exposure of the methods of TPA-3 and associated background information to the scientific community through extensive and timely peer review.

Accomplishments

The Committee commends the staff for its many impressive accomplishments in upgrading and preserving a dedicated HLW PA team in the face of budget cuts and programmatic uncertainties. The organization of the HLW Program around a specific set of KTIs and the grouping of expertise and disciplines within the KTIs provides an important means of focusing the staff's efforts on issues most important to performance of the repository. Performance assessment is important in the staff's efforts to provide integration across disciplines in the KTIs and to set priorities for activities. The Committee was pleased to see the clear integration of PA with other Yucca Mountain activities. This effort has led to the development of sound, near-term plans for prelicensing activities, including resolving outstanding issues and preparing for review of DOE's total system performance assessment supporting the viability assessment (TSPA-VA). The revised and updated TPA-3 code increases the staff's capability in performance assessment modeling. The code should facilitate the KTI investigations with its ability to evaluate the importance of specific site characteristics and the effectiveness of engineered barriers. The ability to conduct sensitivity and uncertainty analyses for subsystems and for the total system is improved. The development of the code is a solid effort and we encourage the staff to pursue aggressively the implementation of TPA-3. Many of these staff activities conform to recommendations contained in the ACNW letter of May 27, 1994, on PA capability.

Engineered Barrier System

The ACNW is concerned about the staff's capability to evaluate quantitatively the engineered barrier system of the proposed Yucca Mountain repository. This concern is punctuated by lessons learned from PA, including the apparently increasing dependence on engineered barriers to demonstrate compliance with a dose- or health-based standard for the repository. With increasing evidence that engineered systems must be an important part of the waste isolation strategy for Yucca Mountain, it is important that these systems receive extensive scientific and engineering scrutiny.

We are concerned about the decision to reduce the effort at the Center on certain KTIs, most

notably those dealing with engineered barriers and radionuclide transport. The shifting emphasis of the DOE to the performance of engineered systems accents the need for the Commission to provide resources to restart work on the KTIs most important to an independent assessment of the performance of engineered systems and near-field radionuclide transport. A concern is that without restarting the work of the NRC staff and the Center, the performance assessment effort, including the TPA-3 code, will not have the scope to assess adequately the DOE work. The Committee urges the Commission to act on this issue as soon as practicable.

Beyond the issue of the scope of the engineered systems assessment capability of the NRC staff, the ACNW believes that added capability is necessary to analyze adequately the engineering design of long-lived, passive high-integrity systems. In particular, additional staff effort is required in engineering analysis, materials science, and chemistry (especially corrosion and colloid chemistry) to have the full capability to assess the engineered systems.

Realistic Performance Assessment Models

The ACNW has three primary points to make regarding the staff's performance assessment modeling activities: (1) the PAs should have a risk-informed perspective; (2) the PAs should be transparent about the supporting evidence (data and information); and (3) the relationship between process model and probabilistic calculations needs to be made clear.

Risk-informed performance assessment provides the opportunity to assess *realistically* the performance of an HLW repository. Our concern is that the TPA-3 activity is relying too much on bounding and worst-case calculations. Although bounding calculations are a very useful part of any technical investigation in providing insights on what is important to the performance measures of a model, such calculations are often of little value in representing what is likely to happen. In the opinion of the ACNW a much preferred approach is to limit bounding and worst-case calculations to the task of scoping the investigation and deciding what may or may not be important to model. Decision making requires more information. The decision-maker needs to know the total range of uncertainty of the performance measures. The primary tool for communicating uncertainty, rather than just an upper bound, for example, is to embed the performance measures in probability distributions so that the full range of values and all their supporting evidence are visible. For example, if the value preferred by the regulator is the 90th percentile value, then it is explicitly clear just how conservative the regulator has chosen to be.

The Committee stresses the importance that the evidence (i.e., data and all other information) that is the basis of the PA model be clearly visible, particularly regarding the abstraction from physical process models to probabilistic calculations. We are especially concerned with the abstraction of information about the engineered systems, especially under the circumstances of not having a fixed design. In addition, supporting evidence for modeling important phenomena such as the chemistry of redox reactions is weak. Our current impression is that more attention is being given to methods than to the required information to support those methods.

Analysis Capability

The ACNW was impressed with the progress in the development of NRC's TPA-3 code. We are anxious to follow the development of TPA-3 and look forward to more discussions with the staff.

The ACNW urges the staff to implement a working code in an expeditious manner so that the code is fully functional as the TSPA-VA analyses are made available to NRC.

The Commission has indicated an interest in moving toward a risk-informed, performance-based philosophy of regulation. Of concern to us is whether the TPA-3 effort is keeping pace with the development of methods and ideas on how to implement such a philosophy.

An issue with TPA-3 is how to verify the code. The problem as stated by the staff is that because the code is designed specifically for the Yucca Mountain site, international bench marking is almost impossible. It is true that parts of the code, such as NEFTRAN (**NE**twork **F**low and **TRAN**sport), have been benchmarked. The NRC staff must see that TPA-3 is benchmarked against applications of other codes to Yucca Mountain. The ACNW also believes that the NRC staff should pursue other avenues of peer criticism of its codes, such as publication in refereed engineering and scientific journals.

Although the ACNW believes that it is important to develop a PC compatible version of the code to reach more users, we would not like to see other important activities compromised to reach this goal. A PC compatible version should not be created at the risk of oversimplification. Meanwhile, to conduct a full range of analyses in reviewing DOE's TSPA-VA, the staff requires the NMSS Advanced Computer System or a suitable alternative.

We believe that these comments provide constructive guidance on the future direction of the performance assessment effort and look forward to following NRC staff progress in this important activity.

Sincerely,

B. John Garrick
Chairman