

April 8, 1999

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

Dear Chairman Jackson:

**SUBJECT: COMMENTS ON THE DEPARTMENT OF ENERGY'S VIABILITY
ASSESSMENT FOR THE PROPOSED HIGH-LEVEL RADIOACTIVE
WASTE REPOSITORY AT YUCCA MOUNTAIN, NEVADA**

In this letter, the ACNW offers comments on the Viability Assessment (VA) of a Repository at Yucca Mountain, which was released by the U.S. Department of Energy (DOE) on December 18, 1998. The ACNW reviewed the primary VA reports, the technical basis document supporting the Total System Performance Assessment for the VA (TSPA-VA), the Repository Safety Strategy, and the most recent NRC Issue Resolution Status Reports. The Committee heard presentations on the VA from DOE representatives at its 105th and 106th ACNW meetings. In addition, the Committee heard a presentation from the NRC staff at the 106th meeting on its preliminary review comments on the VA. The Committee also had the benefit of observing presentations to the Commission on the VA by representatives of a variety of organizations and groups.

A summary of our recommendations follows. These recommendations can be implemented as part of guidance development or made part of the 10 CFR Part 63 rulemaking.

Recommendations

1. The NRC should require DOE to provide a total system performance assessment (TSPA) model of sufficient technical clarity (transparency) so that the staff can readily determine the interrelationships among all modules of the system. This recommendation could be implemented as part of the 10 CFR Part 63 rulemaking.
2. The NRC should require DOE to provide, in the license application (LA) data and information packages, the supporting evidence to the performance assessment (PA) at the module level. This recommendation could be implemented as part of the 10 CFR Part 63 rulemaking.

3. The NRC should provide guidance in the Yucca Mountain License Application Review Plan on what constitutes sufficient supporting data, acceptable model assumptions and abstractions, and acceptable expressions of parameter uncertainty.
4. The NRC staff should be prepared to evaluate engineering designs proposed by DOE. This evaluation will require additional NRC staff with geotechnical, engineered barrier, and waste package design experience.
5. The NRC should outline steps in the licensing process between initial submission of the safety case and final closure of the repository. This recommendation could be implemented as part of the 10 CFR Part 63 rulemaking or guidance development.
6. As part of guidance development for 10 CFR Part 63, the staff needs to identify explicitly the attributes of defense in depth (DID) that apply to waste repositories.

Background

The ACNW framed its review within the overall context of Risk-Informed, Performance-Based Regulation. The foundation for licensing a repository for high-level radioactive waste and spent fuel is expected to be an Environmental Protection Agency standard based on risk (or dose) and a set of implementing NRC regulations (10 CFR Part 63 and other applicable regulations) and guidance.

Demonstrating compliance with the standard will be based principally on a PA that uses a risk-based performance measure (i.e., the expected dose to the average member of the critical group at a specified location). The results from the PA should be expressed as a risk curve (i.e., a complementary cumulative distribution function [CCDF], sometimes referred to as a risk exceedance curve), that shows the likelihood of exceeding different radiation dose levels. The PA, in principle, considers all reasonable mechanisms for failure of the repository to limit appropriately the dose of radiation to the critical group for the required time of compliance.

The VA offers the NRC a chance to assess how DOE's presentation of license supporting material may need to be improved to meet requirements of risk-informed, performance-based criteria in the regulation and how the NRC staff may have to adapt to be able to perform their mission efficiently and effectively. It is within this framework that the ACNW conducted its review.

The ACNW's review of the VA improved our understanding of DOE's approach for moving from the VA to the site recommendation and the LA for the Yucca Mountain repository. The objective of the review was to evaluate the technical capability, tools, and guidance that the NRC staff will need to conduct a defensible review of the Yucca Mountain LA.

The ACNW focused on the technical basis of the safety case made in the VA, including

the ability of DOE to demonstrate the following:

- The design would limit the access of water to the waste packages;
- The waste packages (and cladding) will have long lifetimes relative to the compliance period;
- The release of radionuclides after canisters are breached would be slow;
- The transport of radionuclides in the unsaturated zone could be estimated;
- The transport and dilution of radionuclides in the saturated zone will provide significant buffering of doses; and
- The uptake of radionuclides by biota and the dose to humans could be represented in an acceptable way.
- In addition, to be credible, DOE must present a clear, integrated, probabilistic PA.

The ACNW believes that the most important issues are limiting water access to the waste packages and the need for DOE to present a clear, integrated, probabilistic PA. It is critical that considerable work be done on these issues before submitting a credible LA. The PA is the framework within which all of these issues are put in context for licensing decisionmaking; it is the logic engine for demonstrating the safety of the repository.

Observations and Recommendations

The ACNW is impressed with the improvements in-depth and presentation of the TSPA-VA over previous versions of TSPA. Continued improvements are necessary to make future TSPAs more credible. The description and PA of the geological repository system require much data and many assumptions combined into a complex set of models. The results shown in the VA are sufficiently opaque so that it is often difficult to make reasonable judgments on the adequacy of either the computations or their underlying database.

Observation

The presentation of the VA results continues to need major improvements. More emphasis is needed on a top-down presentation of the total model that clearly traces the critical path of the computation of the performance measure; namely, the radiation risk to a member of the critical group. The components of a traceable path of the radiation risk assessment that need greater visibility and discussion include the hierarchy of the total model, the model components (modules, interfaces, inputs, outputs, etc.), and clearer

visibility of the continuity and traceability of the performance measure calculation

throughout the model.

The ACNW's goal of a top-down presentation is to reveal explicitly the connection and dependence between the performance measure and each component of the model (i.e., rainfall on the site, infiltration to the repository, waste package degradation, radionuclide mobilization, transport through the geosphere and the biosphere, and biological uptake). Refinements are needed in presenting the propagation of uncertainty from the component and subsystem level to total system results. To a certain extent, such results are buried in the VA, but they need to be made more visible to facilitate the mapping of component and subsystem performance to the overall performance of the repository. To be complete, the mapping must be performed in a probabilistic framework to display the role of uncertainty in the process. The Committee believes that employing such techniques will contribute greatly to increasing confidence in the TSPA as it evolves toward a licensing basis.

Recommendation

- 1) The NRC should require from DOE a "transparent" PA that is sufficiently clear to determine the interrelationships among all modules of the system. Requirements for such a presentation can be incorporated into guidance or made part of the 10 CFR Part 63 rulemaking.

Observation

In addition to improving the technical clarity of the PA, the linkages to the underlying supporting evidence must be presented in a way that facilitates review. The database and other supporting evidence for the VA are voluminous and include system (natural and engineered) reliability data, scientific literature, laboratory results, field studies, special analyses, the laws of physics, the principles of chemistry, the abstraction process, and the results of expert elicitation. A major contributor to technical clarity includes the process for choosing conceptual models because both information and models are major sources of analysis uncertainties.

Future TSPAs should provide the rationale for choosing conceptual models for each module, including the process of assembling the modules into the total system model. It is essential that future TSPAs also be specific about what has been synthesized from the various sources and that data and information packages be developed to facilitate the search for supporting information. This is especially true for the major contributors to the performance measures and the associated uncertainties. A special category of evidence comes from the process of expert elicitation. It is not enough to attribute a result to the judgment of an expert; it must be possible to examine the underlying evidence used by the experts in forming their judgments.

Recommendation

- 2) The NRC should require from DOE the traceable linkage of the supporting evidence (data and information packages) to the PA at the module level. Data references must be explicit and, preferably, have electronic links that can be followed easily. Inputs based on expert elicitation must be linked to the supporting evidence for the information provided to and by the experts. Requirements for such a presentation can be incorporated into guidance or made part of the 10 CFR Part 63 rulemaking.

Observation

The case for the safety of a geological repository over tens to hundreds of thousands of years cannot be expressed in absolute terms; as previously stated, the basis for measuring performance must be a risk curve. The ACNW is concerned that the inherent uncertainties in an analysis for such extended periods drive critics to demand that the most conservative assumptions, conceptual models, and parameters be selected at every juncture of the analysis. We very strongly disagree with such an approach. We believe that conservatism is appropriate in regulating nuclear facilities of all kinds, but the appropriate place for conservatism is in the choice of a probability of exceedance of a risk standard.

In the case of a PA for a geological repository, we believe that the analysis should be performed with as nearly realistic assumptions, models, and parameters as possible, including the uncertainty involved. The resultant CCDF derived from the PA would show explicitly the probability that a standard would be exceeded. Increased *conservatism* may be achieved by requiring that the probability of exceeding the standard be less than, say, 1 in 10^6 as opposed to a requirement that it be less than, say, 1 in 10^3 . Obviously, a licensing decision would not be based exclusively on the probability (i.e., the regulation is risk-informed rather than risk-based), but the decision about conservatism is made with the clearest view of the issues after the best information available has been used in an analysis.

Recommendation

- 3) The NRC should provide guidance in the Yucca Mountain License Application Review Plan on what constitutes sufficient supporting data, acceptable model assumptions and abstractions, and acceptable expressions of parameter uncertainty. ACNW recommends that the guidance not require DOE's "complete understanding," but rather reflects the philosophy that even simple approaches may be realistic as long as the full range of uncertainty is captured. The guidance should allow DOE and others to establish relatively clearly when enough data or model support has been attained. The guidance would be most useful if conditions for an acceptable risk exceedance were discussed.

Observation

The VA demonstrates that the ability to restrict the amount of water contacting the waste packages is a critical part of the safety strategy. The extreme importance of limiting the contact of water with waste has led to DOE's increasing emphasis on elements of the engineered barrier system; this would include all aspects of tunnel design as well as the canisters and their contents. The ACNW remains convinced that the NRC staff must acquire expertise in engineering design.

Recommendation

- 4) The NRC staff should be prepared to evaluate engineering designs proposed by DOE. This step implies augmenting the NRC staff with engineers with geotechnical, engineered barrier, and waste package design experience. Part-time consultants with such design experience could be a valuable aid to NRC full-time staff in preparing for and evaluating the LA.

Observation

In listening to presentations from DOE and to some concerns expressed by the NRC staff about the time required for evaluations, the ACNW believes that a potential exists for misunderstanding among the parties. DOE has indicated that some aspects of the repository design likely will change up to and beyond the submission of the LA. An adaptive design strategy is essential to achieve the best results. NRC must be prepared to allow design flexibility and probably will have to adopt a plan of phased licensing. The preclosure period is anticipated to range from 50 to 300 years. During this entire period, the waste will be in storage underground; under active, continuous surveillance; and will be fully retrievable. The final decision on the suitability of the repository for waste disposal will not be made until the end of the preclosure period. New materials, new technical methods, and new societal needs can be expected to arise in this period.

Certain design improvements, such as drift location, support type, waste package design, water diversion strategies, and chemically tailored backfill, are all possible during the preclosure period. Active (and natural) ventilation can be used to remove heat from the waste and reduce adverse thermal effects on the rock and waste package. Also, extensive data can be gathered during the preclosure period to reduce uncertainties in the predicted performance of the repository. On the one hand, it would be irresponsible not to allow such improvements in repository safety. On the other hand, NRC cannot approve the licensing of the repository if the LA and supporting information are not sufficiently well developed to allow the NRC to make a finding of reasonable assurance of safety. A serious evaluation of the competing needs of flexibility and design stability is required.

Recommendation

- 5) The NRC should outline in the 10 CFR Part 63 rulemaking or guidance the steps in the licensing process between initial submission of the safety case and final closure of the repository. Particular attention should be given to the definition of "reasonable assurance" as applied to repository licensing. This definition will provide early guidance to DOE and others on the level of completeness of

design (data, model development, and confirmatory observations) that will be necessary at different phases of the project. The outline would provide guidance on the nature of the process but would not dictate how the licensing boards or the Commission would make decisions.

Observation

DOE continues to develop methods for demonstrating defense in depth (DID). The ACNW remains convinced that the key requirement for DID in a repository is an analysis that clearly quantifies the contribution of multiple barriers, including the uncertainty associated with each barrier to the containment of radionuclides (see ACNW letter of October 31, 1997, "Recommendations Regarding The Implementation of the Defense-in-Depth Concept in the Revised 10 CFR Part 60"). In particular, the multiple barriers of the engineered system and the geological system must be shown to offer protection. We note that it would be imprudent to require a specific percentile contribution from either the geological or the engineered systems because this requirement could lead to impairment of overall performance. That is, if the geological system were required to contribute a certain fraction (say 50%) of the total performance, the applicant might degrade the design of the engineered system to boost the fraction of contribution from the natural system. The ACNW maintains that the appropriate way to judge the case for repository safety is to look at overall performance, as long as there is a clear, quantitative presentation of contributions of individual barriers.

Recommendation

- 6) The NRC staff is committed to developing further guidance on implementing the multiple-barriers approach required in 10 CFR Part 63. As part of this guidance development, the staff should identify clearly the attributes of DID that apply to waste repositories in relation to a risk-informed strategy. In addition, DOE and NRC should develop approaches and methodologies that clearly and transparently identify the contributions of different barriers to the overall performance of the repository.

Technical Concerns About the VA

In general terms, the ACNW shares the staff's concerns on specific technical issues; that is, the adequacy of the database and models in the areas of seepage into drifts, corrosion of alloy-22, failure of fuel cladding, and dissolution of fuel. (The Committee presented details of some of these topics in its letter of September 9, 1998, on the "Issues and Recommendations Concerning the Near-Field Environment and the Performance of Engineered Barriers at Yucca Mountain.") The planned experiments by DOE on seepage into drifts are potentially important, as are continued experiments on corrosion and other phenomena. The ACNW also agrees that data are needed on the saturated zone between Yucca Mountain and Amargosa Valley for the sake of credibility. ACNW disagrees with the staff's concern about the need for more work on Igneous Activity. The Committee has repeatedly asked the staff for analyses that justify the staff's concerns about volcanic activity as a major component of risk at Yucca Mountain, but has yet to see a detailed justification.

Summary

The Committee was impressed with the PA discussion contained in DOE's VA. The material was very professionally written in terms of both text and graphics. The Committee believes that a great deal of excellent work has been performed on the Yucca Mountain TSPA. Confidence in the results is seriously undermined, however, by TSPA's overwhelming size and complexity. ACNW hopes that the recommendations presented in this letter will assist in improving the credibility and transparency of future safety analyses.

Sincerely,

/s/

B. John Garrick
Chairman