

January 12, 1999

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

SUBJECT: COMMENTS ON THE REGULATORY USES OF IMPORTANCE MEASURES FOR WASTE MANAGEMENT AND POSSIBLE APPLICATION TO THE PROPOSED HIGH-LEVEL RADIOACTIVE WASTE REPOSITORY AT YUCCA MOUNTAIN, NEVADA

Dear Chairman Jackson:

In this letter, the Advisory Committee on Nuclear Waste (ACNW) offers suggestions on developing and implementing an importance measures methodology for waste management activities within the NRC. We adopt the NRC staff's definition of *importance measure* as a measure of the absolute or relative role that a component, a series of components, or a scenario has on total system performance. The ACNW believes that an array of risk assessment techniques should be employed by the NRC staff as the agency moves toward risk-informed, performance-based regulation. The addition of a methodology for using importance measures to gain risk insights will help the staff in setting priorities for a variety of waste management activities. Such a methodology will be particularly useful in NRC's High-Level Waste Program, including reevaluating the key technical issue and subissue areas and activities, developing and revising Issue Resolution Status Reports and acceptance criteria; evaluating the Department of Energy's (DOE's) Viability Assessment; verifying the importance of individual systems to overall system performance; and preparing for review of DOE's License Application for the Yucca Mountain Repository.

Our observations and recommendations on this topic are based, in part, on information received during the 102nd ACNW meeting on July 22, 1998. Staff members from the NRC and the Center for Nuclear Waste Regulatory Analyses made a presentation to the Committee on developing importance measures methodology for passive and active systems and implementing this methodology in a multiple-barrier approach for a repository. Several examples of using the proposed importance measures were discussed by the staff. The Committee is greatly encouraged by the staff's work.

The Committee makes the following observations and recommendations:

Observation:

Importance measures provide information that complements that obtained from other related methodologies, such as sensitivity and uncertainty analyses. As noted by the staff, each of these analytical tools has benefits and limitations that must be considered in interpreting the results.

Recommendation:

The Committee urges the continued development and implementation of importance measures methodology for waste management as part of an assortment of tools to be used in evaluating the risk significance of systems in the proposed Yucca Mountain High-Level Waste Repository.

Observation:

The ACNW has previously recommended that the staff develop a systematic method of processing the outputs representative of subsystem behavior (e.g., the engineered barrier system, the natural geological setting) to determine their individual contribution to the overall system performance of the repository. The assessment of importance measures for system and subsystem performance is an important application of such a methodology.

Recommendation:

It is recommended that a method for analyzing results from probabilistic performance assessments to determine rank-ordered contributors to risk be developed in conjunction with the work on importance measures.

Observation:

In general, the Committee agrees with the staff on the differences between importance measures for reactors and importance measures for repository performance. The waste isolation system degradation problem is represented as a series of *continuous* processes rather than as a series of simple failures of active components in a reactor system. Even with two-state components¹ (success and failure), the differences between reactors and repositories tend to diminish with respect to overall system performance and the role of individual components if they are highly redundant and diversified. For example, two-state systems can be aggregated in such a manner as to have failures of individual components manifested as a *continuous* failure process of the total system. In fact, the risk assessments of nuclear power plants have

¹ It should be noted that many individual active components degrade gradually as well. Examples are electrically driven components, valves, sensors, and circuits. Of course, the time constants of degradation may be grossly different between such systems and repository systems.

demonstrated gradual system degradation for many accident scenarios. Thus, the reactor methods may be more easily adapted to the repository performance importance measures than first envisioned.

Recommendation:

The Committee recommends that more detailed reviews be made by the NRC staff of actual applications of importance measures methodology to reactors to develop confidence in their applicability to waste repository systems.

Observation:

Another area in which there is even greater similarity between reactor safety assessment and the performance assessment of repositories has to do with containment response analysis. The event trees that are used to assess the capacity of reactor containments to mitigate radionuclide releases are primarily phenomenologically based. That is, the path taken by the accident is more dependent on parameters such as pressure and temperature, and phenomena such as chemical reactions than on the availability or unavailability of active hardware. Thus, the tools used to measure the importance of individual systems in reactor containments may be suitable candidates for measuring the importance of both natural and engineered barriers in repositories.

Recommendation:

The Committee recommends that within the more detailed reviews of actual applications recommended above, the staff pay particular attention to the use of importance measures methodology in the assessment of reactor containment response.

Observation:

One problem in applying importance measures to waste repository systems may be the level to which they are being taken. For example, rather than focusing on individual components or subsystems, a more realistic approach might be to focus on scenarios. That is, consideration should be given to ranking different scenarios in terms of their contribution to overall performance. Scenarios involving different approaches to containing radionuclides could be compared to identify mitigation systems that are unable to achieve the desired performance level.

It is necessary to be clear on what is meant by "scenarios," if they are to be used in an importance measures methodology. In reactor risk studies, a scenario is a single path through an event tree. In general, a scenario may be defined as the specific combination of events that sequentially connect an initiating event, or an initial condition, to a specific system end state. Examples of end states are release fractions (or rates), dose levels, injuries, or fatalities. In repository performance assessment, there are disruptive scenarios (volcanic activity, earthquakes, extreme cataclysmic events) and nondisruptive degradation scenarios (gradual degradation through natural processes without the stimulant of disruptive events).

Recommendation:

As a complement to the event tree approach noted earlier, consideration should be given to applying importance measures and rankings at the scenario level. The scenarios should be sufficiently detailed to allow resolution between different features, events, and processes. Such a strategy may result in suitably realistic evaluations of different approaches to containing and retarding radionuclides.

Summary:

The Committee believes that the NRC staff should continue its development work on importance measures methodology for assessing nuclear waste management strategies. This effort should be coordinated with any effort to develop a method (event tree based or otherwise) for decomposing performance assessment results into rank-ordered contributors to repository risk. More detailed consideration should be given to reactor risk assessment applications, especially in regard to containment response and source term analysis. The Committee believes that a scenario-based importance measures assessment may be more useful for repository performance assessment than detailed component analyses, providing the approach has sufficient resolution to evaluate selected categories of features, events, and processes.

Sincerely,

/s/

B. John Garrick
Chairman