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Dr. B. John Garrick, Chairman
Advisory Committee on Nuclear Waste
U.S. Nuclear Regulatory Commission
Washington, DC 20555

**SUBJECT: APPLICATION OF PROBABILISTIC RISK ASSESSMENT METHODS TO
PERFORMANCE ASSESSMENT IN THE NRC HIGH-LEVEL WASTE PROGRAM**

Dear Dr. Garrick:

I am responding to your letter of October 31, 1997, to the Chairman, providing the Advisory Committee on Nuclear Waste's (hereafter the Committee's) observations and recommendations on the application of probabilistic risk assessment (PRA) methods to performance assessment (PA) in the High-Level Waste (HLW) program. The Committee's letter, in part, expands on recommendations made in a prior letter to the Chairman (dated October 8, 1997) reporting on the evaluation of the Nuclear Regulatory Commission's PA capability in the HLW program area.

The staff shares the Committee's stated goal for PA in the HLW area -- that there be transparency and clarity in the analysis to support fully the decision-making process. Further, we agree that PA provides the tools to understand the system, so that significant resources are focused on reducing uncertainties that have a significant impact on meeting the compliance measure rather than on reducing uncertainties of small import. The staff is, in fact, implementing this in its day-to-day activities related to identifying and resolving key technical issues. I address the Committee's specific recommendations in detail below.

- The Committee recommends that, to as great an extent as possible, realistic models and parameters be used so that the results of the PAs represent the full range of values that can realistically be supported by the data. In principle, the staff agrees with the Committee's recommendation. However, the level of realism incorporated into abstracted models of any PA code is a function of the data available on site and design features as well as the resources available to carry out the PA. For example, before the discovery of elevated chlorine-36 levels at repository depths in the exploratory studies facilities at Yucca Mountain, the Department of Energy (DOE) used a substantially lower range of values for fluxes through the repository in its PAs than it now uses. At that time, DOE considered that range to be a realistic parameter range although NRC disagreed and used a range with substantially higher values in its Phase 2 assessment (significantly closer to the range DOE now believes is realistic for flux through the repository). Similarly, NRC could ensure that the models in the Total-system Performance Assessment (TPA) 3.1 code more "realistically" depict the hydrologic characteristics of the site (e.g., incorporate 3-dimensional flow and transport models vs. 1-dimensional models). However, because NRC has fewer resources than DOE and because the intended purpose of NRC's code is the review of DOE's PA, some practical simplifications that are consistent with existing data are incorporated into the staff's PAs.

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Although these simplifications tend to move abstracted models toward less realism and more conservatism for selected capabilities, they do not necessarily result in ultraconservative analyses. Moreover, the simplifications are a reflection of NRC's goals for PA in the HLW area. Specifically, PA is used: 1) as a mechanism for developing an understanding of the site so as to facilitate prioritization of staff's work and 2) as a tool to perform an independent, albeit limited, evaluation of DOE's PAs. Regarding the first goal, if the staff finds areas of conservatism that need to be addressed because of the significance to performance, the staff will either reallocate resources to perform the necessary work or advise DOE of the need to address this issue. To accomplish the second goal, the staff has adopted the traditional regulatory approach by having an analysis that is conservative but is realistic enough to evaluate the validity of the licensee's analysis.

- The Committee also recommends that bounding and worst-case calculations be used primarily to screen out issues of little or no concern. The staff believes it is implementing this recommendation in its ongoing PA activities. As noted in the staff's response to the Committee's October 8, 1997, letter, in the development of its TPA 3.1 code, the staff has avoided, to the extent practicable, the use of bounding or worst-case models or parameter values and, instead, relies on models and assumptions that it considers to be technically defensible based on existing data. Simplifications that are prudently conservative are used to address: 1) those instances where narrowing the uncertainty associated with an aspect of repository performance (e.g., long-term performance of spent fuel cladding) may not be necessary to satisfactorily demonstrate compliance; and 2) those instances where schedules and resources do not permit reduction of the conservatism. Nevertheless, the staff intends to reevaluate the assumptions, models, and distributions of parameter values used in its PAs, iteratively, in the normal course of sensitivity studies and code revisions.
- The third recommendation asks that the TPA 3.1 code be reviewed for unrealistic results arising from bounding calculations embedded in the code. The Committee further recommends that ultraconservative models, assumptions, and parameter values be replaced by more realistic assumptions and probability distributions. The staff is implementing the first part of this recommendation in its ongoing PA activities. Specifically, the staff is continuing to implement an iterative process of examining the key assumptions, models, and distributions of parameter values in its analysis to assess: 1) their relative importance to the analysis as tied to the results, and 2) the appropriate levels of conservatism and/or optimism to be used. For example, the preliminary results from ongoing sensitivity studies at the process level suggest that further refinements are needed to provide greater confidence that the results reasonably reflect the performance of the site and reference design for a Yucca Mountain repository. Therefore, NRC and Center for Nuclear Waste Regulatory Analyses (CNWRA) staff are now working on refinements to the code before the initiation of system-level sensitivity studies.

Regarding the second part of the Committee's recommendation, in the existing TPA 3.1 code, the staff incorporated assumptions, models, and distributions of parameter values that reflect the complexity associated with modeling the Yucca Mountain site, the variability of site parameters, and the uncertainty associated with the definition of the

conceptual models and parameter values. The staff has consciously attempted to use models, assumptions, and parameter values that can be technically defended.

- The Committee's fourth recommendation is that an event tree or similar approach for evaluating the TPA-3 model results should be developed and applied. The staff is aware of Dr. Garrick's longstanding interest in applying risk methods to aid in unraveling the results of the PA. The staff agrees and is in the initial stage of evaluating various methodologies that will permit the systematic evaluation of results and the identification of specific contributors to performance. Some of this work is related to importance analysis (see next bullet) and some is progressing in association with the staff's development of a risk-informed implementing rule for HLW. After defining an acceptable approach to identifying specific contributions to performance, it is anticipated that the need for DOE to perform such an analysis will be identified in either the site-specific high-level waste disposal implementing rule or accompanying guidance.
- The Committee's fifth recommendation suggests that appropriate importance measures be developed. As the Committee notes, NRC and CNWRA staffs are currently working on this task.
- The sixth and final recommendation of the Committee is that subsystem performance measures at specific pinch points in the analysis be defined. The staff, in the development of the Issue Resolution Status Report on Total System Performance Assessment, is in the process of defining "pinch points" (i.e., intermediate results from the PA analysis) that could be used as performance indicators at the subsystem level. These "pinch points" will take advantage of the existing model subsystem outputs as the Committee recommends and would, when provided, result in an additional benefit of providing additional transparency to the analysis.

The staff appreciates the Committee's observations and recommendations on the application of PRA methods to PA in the HLW program. The staff is already implementing the recommendations in its day-to-day PA activities and, therefore, believes that its PA activities will achieve the Committee's goal for PA in the HLW area.

Sincerely,


Joseph Callan
Executive Director
for Operations

cc: Chairman Jackson
Commissioner Dicus
Commissioner Diaz
Commissioner McGaffigan
SECY
CIO
CFO