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Rodney C. Ewing

June 28, 1999

Secretary
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Attention: Rulemakings and Adjudication Staff

Dear Sir:

Attached please find comments on the Proposed Rulemaking for Disposal of High-Level Wastes in a Proposed Geologic Repository at Yucca Mountain, Nevada (Federal Register, vol. 64, No. 34, February 22, 1999).

I offer these comments as a private citizen.

Sincerely,

Rodney C. Ewing
Professor

Attachment

JUL - 7 1999
Acknowledged by card .....

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Template = SECY-067

SECY-02

COMMENTS* by R.C. EWING on

PROPOSED RULE FOR DISPOSAL OF HIGH-LEVEL WASTES IN A PROPOSED GEOLOGIC REPOSITORY AT YUCCA MOUNTAIN, NEVADA

*Comments are on those parts of the proposed rule that are placed in quotes and italics below.

I. Background

". . . there has been considerable evolution in the capability of technical methods for assessing the performance of a geologic repository at Yucca Mountain. . . . These changes allow for the use of more effective and efficient methods of analysis for evaluating conditions at Yucca Mountain than do NRC's existing generic criteria. These new methods were not envisioned when the Part 60 criteria were established, and their implementation for Yucca Mountain will avoid the imposition of unnecessary, ambiguous, or potentially conflicting criteria that could result from the application of some of the Commission's generic requirements at 10 CFR Part 60."

Much of the proposed rule is based on the contention that *". . .there has been considerable evolution in the capability of technical methods for assessing the performance of a geologic repository. . ."*; however, the cited documents in support of this contention do not directly address this issue. There has been a considerable improvement in the knowledge of the site, as well as demonstrable improvements in the fundamental knowledge required for geochemical and hydrologic modeling and increased computational capacity and speed as will be required for the PA modeling. However, whether these advances provide a sufficient basis for the description of the long-term behavior of the site as a repository has not been demonstrated. The fundamental assumption (quoted above) is that a probabilistic performance assessment can usefully capture the long-term behavior of highly coupled geologic and engineered systems. In addition to the coupling among the subsystems in a repository, a number of the subsystems may exhibit non-linear behavior. This level of complexity, extrapolated over time, may limit the usefulness of the results of the performance assessment and may not provide results that are within acceptable limits of uncertainty. The assumed efficacy of the performance assessment methodology should be tested by the use of performance assessment models on actual geologic systems before performance assessment is adopted as the sole criterion for compliance. There also should be a clear statement of the level of uncertainty in the performance analysis that will be acceptable as part of a demonstration of successful compliance.

III. Development of a New 10 CFR Part 63

". . . 10 CFR Part 63 that will apply only to the proposed repository at Yucca Mountain."

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"In establishing these criteria the Commission seeks to establish a coherent body of risk-informed, performance-based criteria for Yucca Mountain that is compatible with the Commission's overall philosophy of risk-informed, performance-based regulation."

The evaluation of repository performance and risk depends critically on the scientific basis of the analysis. The proposed rule should be "science-informed". This could be done by including a discussion of "favorable" and "unfavorable" characteristics of the site. As an example, if the Yucca Mountain site is favorable because it is located in an arid environment, this could be stated in the rule. If subsequent scientific studies revealed that the site was not as "dry" as previously thought, then this would be argue against the selection of the site. There should be specific and clear points at which science impacts the final decision of compliance.

There will necessarily be uncertainty in the scientific analysis due to the absence of important data or a lack of knowledge of bounding conditions. The proposed rule does not directly address the basis for the evaluation of the data and models that will be used in the analysis. Based on data and assumptions in the performance assessment, numerical values can be assigned to the projected performance and estimated risk; however, this "quantification" should explicitly incorporate an analysis of the types and degrees of uncertainty in the final result. Surprisingly, the degree of acceptable uncertainty is not included as a criterion in the proposed rule making.

VI. Reference Biosphere and Critical Group for Yucca Mountain

"Based on the present day knowledge of the habits and characteristics of the local population in the vicinity of Yucca Mountain, 63.115 specifies a farming critical group located approximately 20 km south from the underground facility. . . "

Such a calculation is appropriate and reasonable in the evaluation of risk, but it has little to do with the performance of the "underground facility". The original concept of geologic disposal envisioned deep and permanent disposal in a suitable geologic repository. Containment could result from two types of geologic settings: 1.) essentially total containment in the absence of flowing groundwater, or 2.) low-velocity flowing groundwater combined with low, solubility-limited release rates, geologic retardation and a decrease in potential radiation doses to individuals that results from dispersion and dilution during transport (see "A Study of the Isolation System for Geologic Disposal of Radioactive Waste" National Research Council, 1983). The attractiveness of the Yucca Mountain site was, at least initially, based on its location in an arid environment and the absence of flowing groundwater in the unsaturated zone. Under the proposed rule, the site may be judged acceptable due to retardation, dispersion and dilution effects during transport over the 20 kilometers. I had understood that the geologic repository was defined as that portion of the geologic setting that provides isolation of the radioactive waste. By this rule, the alluvium in the Amargosa Desert may be considered as a part of the "permanent" geologic repository.

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A reasonable, and yet conservative, view would argue for a shorter distance (perhaps 5 to 10 kilometers). Reducing the distance would focus the containment strategy and performance on the "underground facility" (as opposed to sorption on alluvium in the valley fill) and provide some margin for changing population densities over time. I also note that the boundary to the accessible environment for the WIPP repository site in New Mexico is 5 kilometers, and considerably less radioactivity will be placed in WIPP.

VII. Compliance Period

". . . The Commission is proposing the use of 10,000 years for evaluating the compliance with the system performance objective . . ."

The compliance period of 10,000 years is based on three considerations by the Commission:

1. The decay of short-lived fission products will substantially reduce the activity.

Although this is certainly true, the repository will also contain substantial quantities of long-lived fission products and actinides (see Figure 3-10, "Spent nuclear fuel – how dangerous is it?" SKB Technical Report 97-13). The recent TSPA-VA showed that the highest levels of exposure due to ^{237}Np, ^{239}Pu, ^{99}Tc and ^{129}I occurred after 10,000 years. Although the 10,000 year period "corresponds to the time period when the waste is inherently most hazardous", the waste remains hazardous after this period. I believe that the remaining inventory of plutonium (after 10,000 years at Yucca Mountain) is greater than that initially emplaced at the WIPP. I also note that the NAS report found no scientific basis for limiting the compliance period to 10,000 years and instead recommended a period that corresponds to maximum risk.

2. The period is sufficiently long to capture the behavior, "robustness", of the repository.

One may argue the converse, that the period of 10,000 years is sufficiently short that it does not capture the geologic behavior of the repository (e.g., volcanic activity and seismic events).

3. The period of 10,000 years is consistent with other regulations (e.g., WIPP).

The point is that this rule making is specifically for Yucca Mountain. This is a site-specific rule making. The amounts and nature of the radioactive waste to be disposed of at Yucca Mountain are completely different from the transuranic waste to be disposed of at WIPP. Once expects that the compliance period will be different for this very different site and types of waste.

VIII. Multiple Barriers and Defense in Depth

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"The Commission does not intend to specify numerical goals for the performance of individual barriers."

The essential argument is that the Commission continues to adhere to a defense-in-depth approach that utilizes multiple barriers, but that in order to allow flexibility in the optimization of the total system performance, numerical goals will not be applied to components of the system. The proposed rule making notes that *"it is arguable whether the existing (or any other) subsystem measures can provide truly independent assurance of total system performance".*

A careful reading of this section must lead one to the conclusion that the fundamental concept of independent multiple barriers has been abandoned. It is true that this repository system is highly coupled; however, I am of the opinion that a number of phenomena, e.g., groundwater travel time in the saturated zone vs. canister corrosion rate, are sufficiently uncoupled to warrant a consideration of subsystem performance requirements. The value of subsystem performance requirements is that they allow scientists and reviewers to focus on specific sub-models in the system (e.g., geochemical models of the near-field environment vs. flow in the saturated zone). In a complicated system, components are more easily analyzed than the whole. If the components cannot be analyzed, then the analysis of total system performance is not made more tractable by combining the subsystem models and having a single, final measure of successful performance. The greater "flexibility" that results from the absence of subsystem performance criteria may well be at the expense of the analyzability of the total system performance.

Finally, no single subsystem component of the repository should be expected to provide for complete compliance, but each subsystem component may reasonably be expected to contribute to partial containment in the absence of successful functioning of other barrier systems. The proposed rule is inconsistent in that it bases the use of performance assessment as the sole criterion on the advances in the PA methodology; however, subsystem requirements are not used because of the difficulty of evaluating the subsystems. If the PA is suitable for evaluating the total system performance, it should be able to provide for the evaluation of subsystem performance.

Finally, understandable and clear subsystem requirements are fundamental to public acceptance. A geologic repository that has travel times to the accessible environment of less than 1,000 years or waste package release rates that are in excess of reasonable materials science performance standards is certainly not acceptable, regardless of the sophistication of the performance assessment.

IX. Performance Assessment

". . . the Commission proposes that the results of performance assessment shall be the sole quantitative measure used to demonstrate compliance . . ."

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Although performance assessment is an essential and highly informative methodology for analyzing complex systems, its efficacy in the application of *"complex predictive models"* to highly coupled, geologic systems extrapolated over extended periods of time has yet to be demonstrated. The rule making also notes that, *". . . the Commission may supplement numerical analyses with qualitative judgements including, for example, consideration of the degree of diversity or redundancy among the multiple barriers of the geologic repository."* To this reader it remains unclear how the single, quantitative measure provided by the performance assessment will utilize the supplemental, qualitative judgements, particularly in the absence of subsystem performance requirements for individual barriers.

If performance assessment is to be the sole criterion, then it is essential that the proposed rule discuss in a substantive and quantitative manner the role of uncertainty in the analysis. There will be uncertainty in the fundamental data base, the knowledge of the site, the conceptual models, the range of expert opinions, and the knowledge of the effects of coupled phenomena on the total system. Each of these uncertainties will propagate through the analysis. The proposed rule should specify a limit on the level of uncertainty in the analysis that will be acceptable prior to a determination of compliance.

If the performance assessment is to be the sole criterion, then it is also important to distinguish between a result that is driven mainly by assumptions about boundary conditions (e.g., climate) vs. the actual properties and behavior of the repository (e.g., sorptive capacity of rock in the unsaturated zone). If the results of the performance assessment depend mainly on assumed boundary conditions and to a much lesser degree the actual properties of the repository, then it is an unacceptable repository site.

In summary, the proposed rule moves the Commission rather far away from the original concept of permanent geologic disposal. This concept is well described by the Nuclear Energy Agency of the OECD ("The Environmental and Ethical Basis of Geological Disposal of Long-Lived Radioactive Wastes", 1995):

> "There is today a broad international consensus on the technical merits of the disposal of long-lived radioactive wastes in deep and stable geological formations. Through a system of multiple containment barriers, this strategy would isolate the waste from the biosphere for extremely long periods of time, ensure that residual radioactive substances reaching the biosphere after many thousands of years would be at concentrations insignificant compared for example with the natural background of radioactivity, and render the risk from inadvertent human intrusion acceptably small. Such a final disposal solution would be essentially passive and permanent, with no requirement for further intervention or institutional control by humans. Although it may be assumed that siting records and routine surveillance would in practice be maintained for many years if society evolves in a stable manner."

The reliance on probabilistic performance assessment as the sole criterion for compliance, the rather distant point of compliance (20 km), the rather short compliance period (10,000

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years) and the absence of subsystem performance criteria on multiple barriers collectively reduce the envisioned "robustness" of permanent, geologic disposal.

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