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

September 27, 1989

MEMORANDUM FOR: ACNW Members

FROM: Mark E. Stella
Advisory Committee Senior Fellow

SUBJECT: TRANSMITTAL OF LATEST DOE POSTCLOSURE RISK ASSESSMENT FOR YUCCA MOUNTAIN

Enclosed is a copy of a document entitled **Yucca Mountain Candidate Site Preliminary Postclosure Risk Assessment**, recently released by DOE to the ACNW. This document is a revised version of a report that has been under review within DOE for the past year. This transmittal from the DOE to the ACNW is believed to be the first official release of the document in any form outside the DOE and its contractor organizations.

Intended Use of the Draft Postclosure Risk Assessment

The project reported upon in the enclosed document is one element of a larger program, the Office of Civilian Radioactive Waste Management (OCRWM) Risk Characterization Program. The Risk Characterization Program develops information to guide programmatic and conceptual design efforts within DOE for the national system for permanent disposal of spent nuclear fuel, commercial and defense HLW, and other radioactive wastes designated for deep geologic disposal.

The present postclosure risk assessment for the Yucca Mountain site appears to be the most comprehensive analysis of its type yet reviewed by ACNW. As an element of the overall DOE Risk Characterization Program, however, the analysis is somewhat artificially constrained in its range of assumptions and data in order to provide DOE management with a coherent basis for associating its results with all other elements of the Program. Hence, one should consider the present document as a stylized analysis of postclosure period risks, that does not necessarily represent a truly unfettered postclosure risk scoping study for the Yucca Mountain repository system as it is presently conceived.

		4c	Encl
K. Stablein (ASS)-DuDOC Full Text		1	1
	NRC POR	1	1
ZZZZ	Central File 01	1	1
	* LPDR	2	2
1/1	Kim Stablein	1	1

The enclosed transmittal letter from Gordon Appel identifies the salient changes and corrections made to the document since its original internal distribution within DOE. It refers to a "major recalculation effort" planned for FY 1990. It is unknown at present whether this planned recalculation is intended to drive the analysis toward a higher degree of specificity and realism (i.e., to approach more closely a true "scoping PRA" status), or whether it is merely intended to achieve greater coherence with the remaining elements of the DOE Risk Characterization Program.

The original letter and document have been placed in the ACNW Program File under file code WE115, **Performance Assessments**.

Review of Analytical Approach and Assumptions

The postclosure risks task of the DOE Risk Characterization Program focuses on the risks associated with the proposed repository at the Yucca Mountain site. No other sites have been considered in this element of the DOE Program. The risk assessment reported upon herein is intended to develop quantitative estimates of the risks of human health effects resulting from the presence of the repository within Yucca Mountain, for a variety of projected situations. The sole waste form assumed for purposes of analysis is unprocessed spent fuel.

The risk estimates contained in Section 9 of the report are based on point estimate analyses performed only for the base case repository conditions. They do not include risks associated with "credible" disruptive events, which for the Yucca Mountain site over the time period of the analysis (one million years following closure) are stated to be climate changes (increased pluviosity) and the occurrence of an extrusive magmatic event. Human intrusion is not considered in the risk calculations. No uncertainty analysis is provided nor are methods for performing such analyses described in the report.

Obviously, additional work will be necessary to adapt the analysis described in the report to the needs of the total system performance analysis required by 40 CFR 191.13(a). The most obvious need is a method to determine how to combine and quantify the probability of occurrence of the various scenarios, including disruptive scenarios, in a manner that meets the intent of the applicable regulation.

The authors of the report, in their survey of repository risk assessment-related literature in Section 2, make note of the fact that neither of the two major risk assessments performed for foreign interests include intrusive events in the risk calculations. Disruptive events are such as to require models for computation of release and transport of radionuclides that

differ substantially from the undisturbed case. Furthermore, the random placement of these disruptive events within the available time window of the 10,000 year assessment period complicates the quantitative analysis of a release CCDF.

It is not immediately apparent that a generally acceptable method for calculating release CCDFs that must incorporate the effects of disruptive events can be developed, although the authors of the postclosure risk assessment refer to optimistic statements made by prior investigators on this subject. A very complex simulation method could conceivably be developed, but the identification of meaningful basic event distributions for computational purposes seems to be the most daunting challenge in this regard.

The dose and risk calculational models included in the report are not factors in the total systems performance analysis. Dose modeling is of course required for demonstration of acceptability against the stipulations of 40 CFR 191.15 and 191.16, although the assumption of an undisturbed repository and the limitation to a 1000 year period of assessment make these requirements seemingly much less restrictive than the total systems performance requirement.

In addition to the risks associated with the undisturbed, base case of the repository system, a separate assessment of the risks associated with an extrusive magmatic event at the site was performed; it is briefly described in Section 7 of the report. An assessment of the effects of increased groundwater recharge rates on risk was also performed and is described in this section.

The time span of the present analysis has been extended (from an initial time horizon of 100,000 years) to a time horizon of over one million years. The basis for this extension was that the ground water travel time used in the calculations was so very long that little if any release of included radionuclides to the accessible environment could be demonstrated within the shorter time period. This conclusion is fundamentally based on the use of the matrix flow model for groundwater passage through the repository horizon, which may not be applicable for a range of possible conditions, as described by the authors of the report.

Section 8 provides the results of a sensitivity analysis performed to assess the effects of differences in the type of nuclide release from the waste form.

Non-radiological risks were not calculated. The figure-of-merit for radiological risk was "adverse excess human health effects", but this measure was not further described in the report. The risk conversion factor used for radiation dose was 200 adverse health effects per one million person-rem population dose. This

conversion was apparently also used to generate estimates of health effects from background radiation so that the number of excess health effects attributable to the release of radionuclides from the repository could be determined.

A human population of 1680 individuals with uniform 70-year life span was assumed to be present throughout the one million year period of the analysis.

Summary of Analysis Results

The DOE transmittal letter refers to an important calculational result appearing in the report's executive summary to the effect that "there were no risks calculated for at least the first 100,000 years after repository closure". This statement could be easily misinterpreted by decision-makers not familiar with the technical basis of the risk calculations and in the opinion of this writer should not be cited without an accompanying description of the analysis from which it has been derived. (In other words, it must be accompanied by the entire report being reviewed in summary here).

For the base case, the anticipated number of excess adverse health effects in a population of 1680 persons each having a lifetime of 70 years was calculated to be 36 cases for the assumed one million year emplacement period. This compares to the calculated number of adverse health effects attributable to background radiation of 33,600 cases for the same period. The magmatic event case risk analysis (using a different methodology for dose and risk assessment) reported a range of 868 to 2825 excess adverse health effects for the first million years.

At 170,000 years the majority of base case health effects were attributable to doses from Carbon-14, Iodine-129, Selenium-79, and Nickel-59. Peak dose was delivered by released Technetium-99 at about 350,000 years but with the nuclides noted previously still contributing to the overall population dose. In the base case, very little dose from the actinides was calculated, these being released to the accessible environment in quantity only very near the end of the one million year period covered by the analysis.

Climate change scenarios leading to increased pluviosity result in significantly increased releases and doses from the heavier elements present in the waste form, in comparison to the base case, due to increased ground water recharge rates at the site. Pluvial scenarios therefore result in orders of magnitude increase in the risk with minimal increases in the mean values of key input parameters. This observation suggests that the utility of risk and release calculations for decision making on the acceptability of the repository will be extremely limited

unless adequate uncertainty analyses can be provided. The time frame for the onset of significantly increased risk also moves much closer to the initial problem time (i.e., final closure of the repository) as assumed pluvial conditions both form a larger portion of the possible repository futures and increase in intensity.

Final Comments

The lack of an uncertainty analysis severely limits the usefulness of the report as a source of decision-making information on repository acceptability.

However, the report provides a relatively succinct accounting of the key issues affecting the feasibility of performing a total system performance assessment and/or a "scoping PRA" for the Yucca Mountain repository. It is also generally useful as a precis for assessing the feasibility of demonstrating acceptable total system performance for any type or location of deep geologic repository as required by 40 CFR 191.

It is not necessary to read in their entirety the sections describing the development of the hydrogeological, waste package release, or far-field transport models in order to obtain from the report a reasonable understanding of the limitations of our present methods for developing useful decision support information on the acceptability of deep geologic repositories.

Given the sensitivity of the risk and release calculations to the various key parameters in the phenomenological models required by the performance assessment logic, one may also identify several presumptions built into the current DOE HLW disposal strategy (and reflected in the postclosure risk assessment) that may need to be re-examined. One key constraint is the assumption that unprocessed spent fuel will form the majority of the waste found in geologic repositories. Section 8 of the report demonstrates the extreme sensitivity of the results to various assumptions regarding the rates and congruency of the release of particular nuclides from the spent fuel matrix. This sensitivity is exacerbated by the non-linear effects of groundwater recharge rates on groundwater travel time in the transition from matrix to fracture flow within the geologic formation. And it is further complicated by the inability of the analyst to determine appropriate methods for inclusion of pluvial scenarios into the overall system performance assessment.

The contents of the report suggest that less attention should be paid to the development of ever more detailed models for repository release phenomena, and more attention given to the limitations of such analyses imposed by the uncertainty in possible

futures and in basic event data required to quantify release and risk measures. The present limitations of the methods and models do not appear to generate the bulk of the enormous uncertainty associated with the repository performance assessment; rather, the basic event data necessary for calculation of release CCDFs and risks per the rubric imposed by the regulations are poorly known (some can never be known) and no amount of methodological sophistication will overcome the limitations imposed by this fact.

Enclosure:

Draft Yucca Mountain Candidate Site Preliminary Postclosure Risk Assessment, June 1988 (Revised)

cc: R. Fraley
R. Savio
R. Major
S.J.S. Parry
D. Okrent, Consultant
M. Carter, Consultant
D. Orth, Consultant
E. Voiland, Consultant
S. Coplan, NMSS

Department of Energy
Washington, DC 20585

SEP 14 1989

Mark Stello
U.S. Nuclear Regulatory Commission
Advisory Committee on Nuclear Waste
Washington, D.C. 20555

Dear Mr. Stello:

In response to your telephone request to Mr. Edward Regnier we are enclosing a copy of the draft report Yucca Mountain Candidate Site Preliminary Postclosure Risk Assessment, June 13, 1988 (Revised).

A previous version of this draft, June 1988, was submitted to a number of Department contractors for technical review. Numerous comments were received that are to be addressed in a major re-calculation effort planned for FY 1990. Two changes have already been made resulting in the June 1988 (Revised) draft. One change corrected a three-order of magnitude error in the natural background health-effects calculations (due to an error in dimensionality). The other added to the executive summary an important calculational result reported in the body of the document, namely that there were no risks calculated for at least the first 100,000 years after repository closure.

If you should have any questions regarding this draft document please contact me or Edward Regnier of my staff on 586-4590.

Sincerely,

Gordon Appel

Gordon Appel, Chief
Licensing Branch

Enclosure: Draft Report Yucca Mountain Candidate Site Preliminary Postclosure Risk Assessment

9000078249, p.