NRC STAFF ANALYSIS OF "RETHINKING HIGH-LEVEL WASTE DISPOSAL"--A POSITION STATEMENT OF THE BOARD ON RADIOACTIVE WASTE MANAGEMENT OF THE NATIONAL RESEARCH COUNCIL

BACKGROUND:

On July 18, 1990, the Board on Radioactive Waste Management of the National Research Council ("the Board") issued a report entitled "Rethinking High-Level Waste Disposal." The Board's report was developed from discussions at a study session convened by the Board in July 1988, to address U.S. policies and programs for high-level waste (HLW) management. The week-long study session was attended by representatives of the U.S. Department of Energy (DOE), the U.S. Nuclear Regulatory Commission (NRC), and the U.S. Environmental Protection Agency (EPA), as well as other knowledgeable persons from the United States and abroad.

The NRC staff has reviewed the Board's report, and this paper gives the staff's analysis. The staff has chosen to focus on what it considers to be the Board's major findings and recommendations related to NRC's regulatory responsibilities regarding high-level radioactive waste repository licensing. The staff's analysis is based on its understanding of the national HLW program as of August 1990, and thus reflects a number of important events that have occurred since the July 1988 study session. These events, some of which have caused or will cause changes to both the NRC and DOE programs, include DOE's issuance of the Site Characterization Plan (SCP) in December 1988, issuance of the NRC staff's comments on the SCP (i.e., NRC's Site Characterization Analysis (SCA)) in August 1989, DOE's announcement of revisions to its program and schedule in November 1989, the appointment of a permanent director of DOE's Office of Civilian Radioactive Waste Management, and the issuance of NRC staff's Regulatory Strategy in October 1988 and first update in June 1990.

CONCLUSIONS:

The staff's major conclusions are:

1. The staff agrees with many of the general principles described in the Board's report and more importantly considers that the NRC regulation and prelicensing process are already consistent with these principles.

2. Uncertainties associated with licensing a geologic repository, including those related to modeling, are recognized by the regulation.

3. The NRC regulation provides flexibility to adjust the subsystem performance requirements for site-specific conditions and designs.

4. The iterative prelicensing process is intended to implement the broad, generic NRC regulations at a specific site. If implemented properly, this process will permit DOE to propose adjustments to the performance allocation for subsystem barriers and their components, to fit the needs for a specific site and specific designs. These adjustments can then

be reflected in adjustments to the subsystem requirements, as permitted by 10 CFR 60.113(b). The staff would review DOE's proposed adjustments and advise DOE accordingly during prelicensing.

5. Proper implementation of the regulation, by both NRC and DOE programs, should continue through the prelicensing process. Features intended to allow flexibility need to be applied effectively by both NRC and DOE.

DISCUSSION:

I. Analysis of Board Findings and Recommendations

A. Overall Finding and Recommendation

The Board concludes that the current approach has resulted in lack of satisfactory progress by the U.S. program and that this is caused by the regulatory requirements (i.e., NRC's 10 CFR Part 60 and EPA's 40 CFR Part 191) and program implementation. Furthermore, it concludes that the current program is unlikely to succeed. The Board therefore recommends an alternative approach that "...will require significant changes in laws and regulations, as well as in program management."

This overall conclusion is primarily based on the following three major findings:

(a) Lack of recognition of uncertainties;
(b) Overreliance on modeling;
(c) Lack of flexibility in regulations and program.

The staff does not consider that the NRC regulation has contributed to any perceived lack of progress. The staff believes that the three major findings in the Board's report reflect a perception of the NRC regulation and implementing process that is different from the staff's view. The staff considers that the regulation is in fact consistent with the following general principles embodied in the Board's three major findings:

(a) Uncertainty must be recognized in safety decisions and absolute certainty cannot be achieved;

(b) Although indispensable, modeling cannot be solely relied on for safety decisions;

(c) Regulatory and programmatic flexibility are needed to best deal with uncertainty.

The staff also observes that while the regulation has always been consistent with these principles, improvements which increase flexibility have been made by both NRC and DOE to the implementation of the prelicensing process since the Board's study session was held two years ago. Further, improvements can and should continue to be made, and the NRC staff is committed to do so.

One of the major difficulties in assuring the NRC and EPA regulations can be implemented is that they have never been applied to the full universe of data that is expected to come from site characterization and be included in the repository license application. As a result the debate necessarily takes on a theoretical tone, with few technical details. While recognizing this limitation, the staff believes that the case is not made for significant changes to the NRC regulation. Instead, proper implementation of the flexibility inherent in the NRC regulation by both NRC and DOE programs should continue through the ongoing, site-specific, iterative prelicensing process. Already existing features intended to allow flexibility in the application of the regulation and prelicensing process to a specific site need to be clearly understood by all parties and applied effectively by both NRC and DOE. If needed, changes to the regulation can be made during and after site characterization.

B. Specific Recommendations for NRC

Of the seven specific recommendations made by the Board, one is addressed to NRC. The NRC staff considers that two other recommendations, one addressed to DOE and one addressed to EPA, also involve NRC and are specifically addressed below.

1. Recommendation No. 3, addressed to NRC

The Board recommends that NRC reconsider the detailed licensing requirements which the staff understands to be directed at the subsystem performance objectives set out in 10 CFR 60.113. As a matter of fact, the staff is already reconsidering each of these subsystem performance objectives, with a view to possible clarifications or improved implementation. The staff's Regulatory Strategy (SECY-88-285 and SECY-90-207) further explains the staff's plans in this regard. As to the specific issues concerning the need for accommodating uncertainty (i.e., not requiring unreasonable levels of evidence) and preserving the flexibility to deal with new information, including consideration of design changes as appropriate, see Section C below. The staff notes, however, that the perception of insufficient flexibility may reflect some misunderstanding of what NRC regulations do in fact require -- as indicated, for example, by the incorrect interpretation that some parties have made regarding the "1000-year" containment period for waste packages (see Section C).

2. Recommendation No. 4, addressed to DOE

The Board also encourages DOE to become "... a more responsive player in these regulatory issues," and "... publically negotiate prelicensing agreements..." with NRC on the goals of the regulations, treatment of uncertainty, and performance assessments. The staff agrees with the Board's encouragement of DOE. NRC and DOE have had prelicensing consultations for many years. These consultations are open to the public and involve participation by the State of

Nevada and affected counties. However, the staff has often found in the past that DOE is reluctant to meet and discuss potential licensing issues in a open and public forum. The recent interactions with DOE indicate that future consultations may improve. The NRC staff has been meeting and will continue to meet regularly with DOE, to agree on important topics for consultations, including the topics suggested by the Board. It is important to recognize, however, that both as a matter of law and policy, final judgments with respect to the acceptability of a particular repository must await consideration in formal licensing.

3. Recommendation No. 2, addressed to EPA

The Board's recommendations for EPA regarding the quantitative probabilistic nature of the release standard, what will constitute a reasonable level of assurance, and the preference for a dose standard are also of interest to NRC, because of their significance to NRC's implementation of EPA's HLW standards. The NRC staff shares the Board's concern about the uncertainties associated with implementing the quantitative probabilistic approach in the EPA HLW standards and is actively discussing with EPA questions related to improving implementation. However, it should be kept in mind that although the EPA standard may be stated in probabilistic terms, the decision of whether or not a particular repository meets the standard rests ultimately on judgment in applying the qualitative "reasonable assurance" test, rather than absolute certainty. (See Section C1 for further discussion of what constitutes reasonable assurance.)

The staff recognizes that a standard expressed in terms of dose or risk like the one suggested by the Board is attractive because of its clear correlation with protection of public health and safety. When a standard limits releases of radioactive materials, as EPA's HLW standards do, the relationship to public health protection is not as readily apparent. There is, however, a major advantage to such a release limit standard -- a significant simplification in the analyses required to evaluate compliance. Standards that limit dose or risk require identification of environmental pathways and demographic assumptions (e.g., population distributions and dietary habits) far into the future, and thus introduce large uncertainties into analyses of compliance. The alternative approach adopted by EPA addresses and resolves these uncertainties by rulemaking, allowing a simpler evaluation of compliance for a specific repository. This simplification results in a somewhat less flexible standard, which precludes consideration of potentially beneficial environmental pathways and demographic characteristics of a specific site. The staff considers that this loss in flexibility would be outweighed by the advantage of precluding sources of additional uncertainty in repository performance assessments.

C. NRC Staff Views of the Board's Major Findings

1. Recognition of Uncertainties

10 CFR Part 60 and the NRC staff's implementation of this regulation clearly recognize the uncertainties inherent in a geologic repository. Both the regulation and statement of considerations state that reasonable assurance, not absolute proof, is the standard. 10 CFR 60.101 (a) (2) gives the following standard of proof:

> While these performance objectives and criteria are generally stated in unqualified terms, it is not expected that complete assurance that they will be met can be presented. A reasonable assurance, on the basis of the record before the Commission, that the objectives and criteria will be met is the general standard that is required. For 60.112, and other portions of this subpart that impose objectives and criteria for repository performance over long times into the future, there will inevitably be greater uncertainties. Proof of the future performance of engineered barrier systems and the geologic setting over time periods of many hundreds or many thousands of years is not to be had in the ordinary sense of the word. For such long-term objectives and criteria, what is required is reasonable assurance, making allowance for the time period, hazards, and uncertainties involved, that the outcome will be in conformance with those objectives and criteria. Demonstration of compliance with such objectives and criteria will involve the use of data from accelerated tests and predictive models that are supported by such measures as field and laboratory tests, monitoring data and natural analog studies.

Moreover, the statement of considerations accompanying promulgation of 10 CFR Part 60 (48 FR 28194, June 21, 1983 at 28204) elaborated, in part as follows:

> This standard [reasonable assurance], in addition to being commonly used and accepted in the Commission's licensing activities, allows the flexibility necessary for the Commission to make judgmental distinctions with respect to quantitative data which may have large uncertainties (in the mathematical sense) associated with it.
>
> ...the Commission will not be able to rigorously determine the probability of occurrence of an outcome that fails to satisfy the performance standards. It must use some other language, such as "reasonable assurance," to characterize the required confidence that the performance objectives will be met.

The staff agrees with the Board's conclusion that recognition of uncertainty in decision-making is a necessary part of achieving public acceptability, but regards the Commission's policies and regulations to be fully consistent with this conclusion.

2. Use of Modeling

The staff agrees with the Board's observation that modeling is indispensable for understanding repository performance and focusing on uncertainties significant to performance. The staff also recognized the limitations of modeling and therefore 10 CFR 60.101 (a) (2), as quoted above, recognizes that predictive models will not be relied on solely but will need to be supported by field and laboratory tests, monitoring data, and natural analog studies. The staff also recognizes that expert judgment will factor into such areas as interpretations of data and model assumptions.

The staff's concern over limitations of present modeling, coupled with the value of modeling to focus both the DOE and NRC programs, has led the staff to place a high priority on iterative performance assessment. One of the major comments in the staff's SCA on DOE's SCP was the need for DOE to begin using iterative performance assessment to help guide its site characterization and design programs and to improve methodologies. Likewise, the staff has an ongoing program to develop its own capability to conduct iterative performance assessments as a tool to help determine acceptable and feasible methods and to knowledgeably review DOE's total systems performance assessments. However, to date, DOE has not come forward with any preliminary performance assessments of the Yucca Mountain Site.

3. Flexibility in Regulations and Program

The staff agrees with the Board's conclusions that flexibility is needed to deal with uncertainties. Flexibility was a major issue considered by the staff, Commission, and commenting parties as the regulation was developed. The significant differences between nuclear power plants and a geologic repository were recognized and resulted in a regulation and licensing process better suited for the unique problems expected in developing a first of a kind deep geologic repository. What resulted was a performance-oriented regulation that attempts to give a reasonable degree of flexibility within a framework of general regulatory requirements. This approach appears to be consistent with the Board's desire for broad requirements that are not immutable contraints.

Given the broad generic regulation, activities carried out during the prelicensing process are necessary to implement the regulation at a particular site. The successful implementation of the regulation depends to a large extent on efforts during the

prelicensing, site characterization phase to determine how a demonstration of satisfactory performance can best be accomplished. Both the regulatory language and the prelicensing interactions among all interested parties accommodate the very real need for flexibility. Flexibility features in both the regulation and prelicensing/licensing process are discussed further below.

a. Subsystem Performance Objectives

As mentioned previously, the staff considers the subsystem performance objectives and criteria are general requirements rather than detailed requirements prescribing specific engineering design. Furthermore, although the numerical nature of the subsystem performance objectives can give the impression of absoluteness, it should be recalled that "reasonable assurance" rather than absolute certainty is the standard of proof for meeting these requirements (see Section IC1). In addition, it should be emphasized that the numerical values themselves are subject to adjustment so as to take into account unique features of a specific site or design that would contribute to overall performance. This is not an exemption from the regulation, but a provision that is expressly set out in the regulation itself. 10 CFR 60.113 (b) states that:

> On a case-by-case basis, the Commission may approve or specify some other radionuclide release rate, designed containment period or pre-waste-emplacement groundwater travel time, provided that the overall system performance objective, as it relates to anticipated processes and events, is satisfied.

Questions have been raised by DOE and others about perceived limitations of the subsystem requirement for waste package containment in 10 CFR 60.113 (a)(1)(ii)(A). Specifically, it was unclear to DOE and others if this requirement was a cap on the waste package lifetime or a limitation on the credit that can be taken in engineered barrier system or overall repository system performance assessments. The requirement, if so interpreted, might indeed have the effect of unduly reducing DOE's flexibility. Such an interpretation could also give the incorrect impression that the regulation deemphasizes the importance of the engineered barrier system and therefore emphasizes the natural system.

In order to resolve this question about the regulation, the staff, based on the information in the statement of considerations, issued Staff Position 60-001 on July 27, 1990, which clarifies the meaning of this requirement and explains the flexibility in the regulation and the staff's interpretation of the regulation. The staff's position is that this requirement:

> ... is a minimum performance requirement which is not intended, and should not be interpreted, as a cap on the waste package lifetime or a limitation on the credit that can be taken (in engineered barrier system and overall repository system performance assessments) if the waste package is designed to provide containment in excess of 1000 years.

Yet, while the staff regards the subsystem performance objectives as having considerable flexibility, these objectives do have a role in implementing the Commission's defense in depth philosophy and will need to be implemented in a manner that enhances confidence in overall system performance.

b. Regulatory Strategy

The staff's Regulatory Strategy (SECY-88-285), issued in October 1988, reflects an internal process for identifying and correcting deficiencies with the regulation (including requirements that might prove to be unnecessary to protect public health and safety). The staff has recently had its contractor, the Center for Nuclear Waste Regulatory Analyses, complete an independent analysis of the regulation to identify potential deficiences. The staff also has used and will continue to use the experience of the staff and DOE with implementing the regulation, during site characterization at the Yucca Mountain site, to identify deficiencies.

Once potential deficiencies are identified, the staff's Regulatory Strategy also indicates generally how they will be corrected by using either rulemakings, staff positions, or regulatory guides. The first update to the Regulatory Strategy in SECY-90-207 lists a number of potential rulemakings, staff positions, and regulatory guides intended to address identified deficiencies and other regulatory needs. The Staff Position 60-001 mentioned previously is one example of how the staff has addressed a perceived deficiency. Work is also underway to examine each of the post-closure subsystem performance objectives (i.e., substantially complete containment, engineered barrier system release, and groundwater travel time/disturbed zone). The staff's strategy is to refine these requirements.

Although refinements may be beneficial, the staff sees no justification for eliminating the quantitative subsystem performance requirements. These requirements are a necessary feature of the regulation used to implement the multiple, independent barrier concept and to deal with uncertainties in estimating overall system performance. Most importantly, as discussed above, the explicit provision for adjustments (i.e.,

10 CFR 60.113(b)) assure that necessary accommodations can be made so long as there is no weakening of the protection of public health and safety.

c. Licensing and Prelicensing Process

The overall licensing process was also designed to account for an evolving program. The regulation and the Regulatory Strategy in SECY-88-285 describe the five phases of repository licensing. Each phase represents a step in an evolving decision-making process incorporating new information and design changes with each step.

More specifically, the staff considers that the prelicensing phase of the licensing process has been designed to allow additional program flexibility in many ways to accommodate the evolving and exploratory nature of the program. As mentioned previously, the prelicensing/site characterization process recognized by the Nuclear Waste Policy Act (NWPA) and implemented by both NRC and DOE is the intended mechanism to develop the detailed site, design, and performance information necessary for DOE to demonstrate compliance with the regulation for the Yucca Mountain site. It is through review and consultation, between NRC and DOE that the application of the generic regulation can be clarified for the Yucca Mountain site. The State of Nevada and units of local government have had and will continue to have the opportunity to participate in all such consultations between the staff and DOE, and the public is invited to observe. This ongoing, iterative prelicensing process also includes DOE's preparation of semi-annual progress reports which document progress and changes as the program evolves and adjusts to new information obtained about the site. Documentation is needed for purposes of licensing as well as informing the public. This process, therefore, anticipates and allows for changes to be made as site characterization and design activities proceed.

Within the site characterization process, NRC has also agreed to DOE's issue resolution strategy and performance allocation process. This process, described in DOE's SCP, is intended to be a decision-aiding process for eventually determining if enough information has been collected and adequately assessed, for the Yucca Mountain site, to demonstrate compliance with the regulatory requirements. This process gives direct consideration to how uncertainties should be treated. It also permits DOE to propose adjustments to the performance allocation of the subsystem barriers and their components, to fit the needs for a specific site and specific designs. These adjustments can then be reflected in adjustments to the subsystem requirements, as allowed for in 10 CFR 60.113(b). The staff would expect that initial performance allocation goals would change as new information about the site is

obtained and as DOE refines its conceptual designs. Finally, the staff would review DOE's proposed adjustments, and if the staff concluded that the adjustment was justified in light of the information at hand, it would so advise DOE as it completes the preparation of a License Application.

d. DOE Program Implementation and Quality Assurance

In the staff's view, DOE's schedule prior to its November 1989, announcement of a revised schedule was overly optimistic. NRC expressed concerns about DOE's unrealistic schedule in it's SCA and in a September 16, 1988, letter to DOE on the Draft 1988 Mission Plan Amendment. The time allocated in the old schedule for the prelicensing/site characterization process would have limited DOE's implementation of many of the flexibility features of the prelicensing process discussed previously in Section IC3c. The staff considers that DOE's revised schedule is an improvement. It is a more realistic schedule given the complex and exploratory nature of the program. It also provides DOE and other parties with the time needed to properly implement the prelicensing/site characterization process.

A source of perceived inflexibility that has been previously identified by the Board is in the area of quality assurance. This concern prompted the NRC staff to examine both its regulation and the implementation of the regulation by DOE. Discussions also have been held with DOE and other parties. As a result NRC and DOE have agreed that NRC's regulations and guidance have not restricted flexibility. Rather, the root cause of any such perceived problems is most likely DOE's and its contractors' overly restrictive implementing procedures. The staff understands that DOE is pursuing resolution of this matter. The staff intends to follow DOE's resolution of implementation problems to ensure that the current understanding of the root cause of the problems is correct.

Another source of inflexibility mentioned in the Board's report is DOE's attitude of "getting it right the first time." In the past, the staff has observed a somewhat different DOE attitude of taking a position and assuming that it is the right way, without fully considering differing or alternative comments and positions. For example, in DOE's consultation draft SCP, such an attitude was reflected in DOE's preference for optimistic assumptions and lack of consideration of alternative conceptual models of the Yucca Mountain site, despite the current limited level of knowledge about the site. (However, it needs to be noted that the staff's comments and consultations with DOE about this concern have ultimately resulted in improvements in DOE's consideration of alternative conceptual models in its SCP). Such a DOE attitude is also

reflected in the difficulties the NRC staff has had in obtaining indepth technical consultations on problems until DOE has developed a final position. The staff has noted this concern in its comments on the progress of the pre-license application consultation program in the Quarterly Progress Reports to the Commission.

MEMO TO TAYLOR

MEMORANDUM FOR: James M. Taylor
Executive Director
for Operations

FROM: Robert M. Bernero, Director
Office of Nuclear Materials Safety
and Safeguards

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(Signed) Robert M. Bernero

Robert M. Bernero, Director
Office of Nuclear Materials Safety
and Safeguards

Enclosure: As stated
cc: E. Beckjord, RES
W. Parler, OGC
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