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MEMORANDUM FOR: James L. Blaha
Assistant for Operations
Office of the Executive Director
for Operations

MAR 11 1994

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

SUBJECT: TRANSMITTAL OF INFORMATION RELATING TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING ON MARCH 14, 1994, TO THE COMMISSION

Enclosed are six copies of the following information for the Commissioner's Technical Assistants to use in preparing for the subject briefing:

- A brief statement of the staff's activities directed toward providing guidance to the U.S. Department of Energy regarding the implementation of 10 CFR 60.113 (Enclosure 1).

- Background information on the staff's activities related to the performance objective defined in 10 CFR 60.113 (a)(2) (groundwater travel time and the disturbed zone (Enclosure 2)).

- Background information on the staff's views on implementing the provision of 10 CFR 60.113 (b) that allows adjustments to the subsystem performance objectives (Enclosure 3).

This information is related to Page 6 of the Nuclear Waste Technical Review Board's written presentation to the Commission and viewgraph 9 of that presentation.

If you have any questions regarding this information, you may contact B.J. Youngblood of my staff at 504-3404.

Original signed by
Robert M. Bernero

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

Enclosures: As stated

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DIVISION OF HIGH-LEVEL WASTE MANAGEMENT STAFF'S ACTIVITIES RELATED TO 10 CFR 60.113

Over the past several years the staff has directed efforts toward identifying, understanding, and addressing technical and regulatory uncertainties related to 10 CFR Part 60. As part of these efforts, the staff has initiated activities toward establishing guidance related to 60.113, including the subsystem performance objectives and the provision for flexibility in 60.113 (b). The staff agrees with the Nuclear Waste Technical Review Board that guidance on the groundwater travel time criterion of 60.113 is needed. The staff also agrees that it should not wait until the U.S. Environmental Protection Agency standard is revised and, therefore, has initiated efforts on establishing guidance related to the groundwater travel time performance objective. The final results of the staff's guidance in this area will be contained in the License Application Review Plan, as it is de

ENCLOSURE 1

BACKGROUND RELATED TO 10 CFR 60.113 (a)(2)
(GROUNDWATER TRAVEL TIME)

ENCLOSURE 2

BACKGROUND: Groundwater Travel Time/Disturbed Zone.

The Nuclear Waste Policy Act mandates that the technical criteria developed by the NRC "shall provide for the use of multiple barriers in the design of the repository." The Commission has identified three primary barriers to the release of radionuclides: the geologic setting, the design and configuration of the repository, and the waste package. The performance objective for the geologic setting is currently defined in 10 CFR 60.113(a)(2) as follows:

> "The geologic setting shall be located so that pre-waste-emplacement groundwater travel time from the disturbed zone to the accessible environment shall be at least 1000 years or such other travel time as may be approved or specified by the Commission."

The requirement for multiple barriers addresses the need to reduce the various sources of uncertainty in predicting the potential long-term performance of the repository so that in the view of the Commission it can "have confidence in the ability of the geologic repository to contain and isolate wastes for an extended period of time." A premise of the multiple barrier approach that underlies the defense-in-depth concept is that barriers can be prescribed that act independently and thereby enhance the confidence that the wastes will be isolated. To implement the defense-in-depth concept, it was determined that it was appropriate to include reasonable, generic requirements that, if satisfied, will ordinarily contribute to meeting standards and that quantitative measures were important in conveying the degree of confidence necessary to make the required licensing decisions.

In general, the physics of groundwater flow under saturated conditions are better understood that the physics of groundwater flow under unsaturated conditions. For example, saturated flow involves the interaction of only two phases (water and rock), and unsaturated flow involves the interaction of three phases (water, rock, and air). Because of this, the modeling of unsaturated flow involves, for example, an understanding of the wetting characteristics (e. g., at what point does water begin to flow) of the geologic medium and the relationship of air permeability measurements to water permeability. Consequently, over the last several years, efforts have been focused on gaining a better understanding of unsaturated flow. Through a systematic regulatory analysis (SRA) of GWTT, two technical uncertainties have been confirmed.

The first technical uncertainty relates to establishing a methodology for determining the fastest path of likely radionuclide travel. Because of uncertainty in the spatial variability in hydraulic properties of geologic media, the fastest path of likely radionuclide travel is a distributed parameter in time and space rather than a single value parameter. As such it can be quantified as a cumulative frequency distribution of "fastest" paths. It has been suggested that the current standard does not adequately address this fact. Because groundwater flow can be considered a stochastic process, uncertainty analyses will provide multiple predictions of groundwater flow velocity fields. It is important to note that the uncertainty in predicted velocity fields will be required input for performance assessments, regardless of the performance standard to be evaluated (such as cumulative release of radionuclides, dose, GWTT or any other suggested groundwater flow based parameter for the geologic setting, such as flux). The staff is currently

evaluating methodologies for determining compliance. During this evaluation, the staff will consider whether other expressions of groundwater flow (such as the mean "fastest path" for GWTT or a flux-based parameter) would serve as a more meaningful indicator of the performance of the geologic setting. In the rationale accompanying the final rule (10 CFR 60), the staff presented analyses that demonstrated the functional relationship between GWTT and release of radionuclides for a variety of geologic media. Those analyses supported the conclusion that a 1000 year GWTT would enhance the confidence that the wastes will be isolated. Although it has been suggested that a flux-based parameter might be a better measure of the quality of the geologic setting, the staff is not aware of any analyses to specifically support that suggestion.

The second technical uncertainty relates to determining the extent of the disturbed zone. The disturbed zone is defined as that "portion of the controlled area the physical or chemical properties of which have been changed as a result of underground facility construction or as a result of heat generated by the emplaced radioactive wastes such that the resultant change of properties may have a significant effect on the performance of the geologic repository." The disturbed zone concept was established as a means to account for some post-closure effects on the groundwater flow system at a time when "coupled" process models were not readily available for evaluating groundwater flow systems. However, determining the extent of the disturbed zone appears to be enigmatic. This is due to the implied necessity to establish unspecified, quantitative limits for some properties of the geologic setting wherein any construction- or heat-induced changes in those properties beyond those limits would have a significant effect on the performance of the geologic repository. Numerical analyses of the response of the geologic setting (i. e., the groundwater flow system) undertaken by the staff have not yielded any meaningful quantitative limits for properties considered (temperature or liquid saturation) that could serve as useful criteria for determining the extent of the disturbed zone when considering the effects of thermal induced buoyancy on the groundwater flow system. The staff is continuing to evaluate whether the disturbed zone is a quantitatively tenable concept and is considering whether a "post-waste emplacement" performance objective for the geologic setting (wherein repository induced effects are directly coupled into the compliance evaluation) would be a more demonstrable indicator of the performance of the geologic setting.

BACKGROUND RELATED TO 10 CFR 60.113 (b)

ENCLOSURE 3

SEP 14 1990

MEMORANDUM FOR: Commissioner Curtiss

FROM: James M. Taylor
Executive Director for Operations

SUBJECT: NRC STAFF ANALYSIS OF "RETHINKING HIGH LEVEL WASTE DISPOSAL"

Enclosed is the staff analysis dated September 12, 1990, of "A Position Statement of the Board of Radioactive Waste Management" of the National Research Council. This document supersedes the version provided to you on August 29 and will serve as the basis for Mr. Bernero's remarks at the September 17-18, 1990 Symposium on Radioactive Waste Repository Licensing sponsored by the Board on Radioactive Waste Management of the National Research Council. No formal remarks are being prepared. After the discussion at the symposium, the staff will prepare a formal analysis for transmission to the Commission.

Also enclosed is a draft of EPA's presentation at this symposium.

Original Signed By:
James M. Taylor

James M. Taylor
Executive Director
for Operations

Enclosures:
As stated

cc: Chairman Carr
Commissioner Rogers
Commissioner Remick
W. Parler, OGC
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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.

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 [illegible] licensing process has been designed to allow additional [illegible] 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 [illegible] of the flexibility features of the prelicensing p[illegible]scussed previously in Section 1C3c. The staff consider[illegible] 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

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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July 31, 1992

MEMORANDUM FOR: Commissioner Curtiss

FROM: James M. Taylor
Executive Director
for Operations

SUBJECT: RESPONSES TO QUESTIONS RAISED AT JULY 1, 1992, BRIEFING

Enclosed are the responses to four questions you posed to the staff during its July 1, 1992, briefing to you on issues in the high-level waste repository program.

James M. Taylor
Executive Director
for Operations

Enclosure: As stated

cc: The Chairman
Commissioner Rogers
Commissioner Remick
Commissioner de Planque
SECY
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Question 1. Can the subsystem objectives be used as a trade-off against one another?

Answer.

o The history of the development of the subsystem performance objectives in 10 CFR Part 60 supports a position that these performance objectives were not generally intended to be u[illegible] a trade-off against one another. A premise of the multiple barrier approach is that barriers can be prescribed that act separately and thereby enhance the confidence that the wastes will be isolated. As noted in the statement of considerations accompanying the final rule (48 FR 28196, June 21, 1983), the regulatory strategy favored use of the multiple barrier approach in which each of the major elements of the geologic repository had a prescribed minimum performance standard; achieving these standards collectively would assist the Commission to determine that the EPA's high[illegible]aste standard would be met. Given this regulatory strategy, [illegible] act that a licensee proposes an enhanced waste package design, for example, does not of itself relieve it from the requirements to demonstrate compliance with the other subsystem performance requirements. However, the text of the rule is sufficiently flexible that DOE could propose, and the Commission could approve or specify, some other values for the subsystem performance requirements (by virtue of 10 CFR 60.113(b), which allows consideration of "particular sources of uncertainty in predicting the perf[illegible]ce of the geologic repository.") See id., "Single vs. Multiple Performance Standards."