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JAN 26 1989

APPROVE APE/UPE RULE

MEMORANDUM FOR: Robert E. Browning, Director
Division of High-Level Waste Management, NMSS

FROM: Ronald L. Ballard, Chief
Geosciences and Systems Performance Branch
Division of High-Level Waste Management, NMSS

SUBJECT: REQUEST TO BEGIN A RULEMAKING TO CHANGE DEFINITIONS FOR ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

We request your approval to initiate a rulemaking to amend 10 CFR Part 60 to: (1) modify the definition of "Anticipated Processes and Events" and "Unanticipated Processes and Events," as contained within 10 CFR Section 60.2; (2) modify portions of 10 CFR Part 60.113, which describe the use of these terms; and (3) modify both the definition of the term "Geologic Setting" and the portion of 10 CFR Section 60.102 dealing with the concepts underlying the term. These modifications reflect the decisions reached during a meeting with you on January 17, 1989, at which time alternative approaches were discussed.

On February 29, 1988, the Commission published for comment a draft Generic Technical Position (GTP) entitled "Guidance for Determination of Anticipated Processes and Events and Unanticipated Processes and Events." Analysis of the comments received has indicated that there are several portions of the definitions which could be highly contentious during the licensing process. This could create potential delay in licensing, and result in the inability of the U.S. Nuclear Regulatory Commission (NRC), the U.S. Department of Energy (DOE), and affected States and tribes to meet the Nuclear Waste Policy Act (NWPA) timeframe. In addition, there are certain portions of the rule where strict interpretation could lead to illogical technical conclusions. The proposed rulemaking is, therefore, an attempt to streamline the licensing process by resolving these points of contention before DOE's submittal of its application for construction authorization.

As the proposed rulemaking only applies to the period after permanent closure of the geologic repository, it will have no direct effect on the activities of any group in the NRC, except the Division of High-Level Waste Management (HLWM).

We plan to expedite the rulemaking so that the proposed rule can be submitted to the Commission in 1990. Based on the fact that the Division published a draft GTP for public comment, and the proposed rulemaking generally follows the guidance presented within the draft GTP, we see no need for an Advance Notice of Proposed Rulemaking. Based on the Standard Planning Factors, presented in Office of Nuclear Material Safety and Safeguard (NMSS) Policy and Procedures Letter 1-29, Petitions for Rulemaking (Parts I and IV), this omission should expedite our schedule for this rulemaking by 24 weeks.

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Our timetable, based on these modified NMSS Standard Planning Factors, is as follows:

January 1989	Director, HLWM approval
July 1989	Executive Director for Operations (EDO) approval to start rulemaking
October 1989	Proposed rule for Division review
January 1990	Office concurrence on proposed rule completed
March 1990	Proposed rule package to EDO
July 1990	Proposed rule published
January 1991	Final rule published

We have enclosed a proposed rulemaking approval package consisting of the NMSS findings/options (Attachment 1) and a draft of the proposed rulemaking package, including the suggested wording of the proposed rule modification (Attachment 2). In order to meet the above schedule your approval of this package is needed in January 1989. Transmittal of this package to the Office of Research will indicate this approval. Following the development of the cost-benefit analysis by the Office of Research, this package should be transmitted back to this Division for finalization of the requirements for forwarding to the Director of NMSS for approval.

/S/

Ronald L. Ballard, Chief
Geosciences and Systems Performance Branch
Division of High-Level Waste Management, NMSS

Attachments:
As stated

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NOTE: ATTACHMENTS SENT TO LLS TO COMBINE W/THIS MEMO. 1) ATTACHMENT 1; 2) ATTACHMENT 2.
[1) & 2) = CALLUP NAME]

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ATTACHMENT 1

NEW RULEMAKING ACTIVITY

REVISION OF THE DEFINITIONS OF ANTICIPATED PROCESSES AND EVENTS AND UNANTICIPATED PROCESSES AND EVENTS

1. THE PROBLEM

As defined within 10 CFR Section 60.2, "Anticipated processes and Events" and "Unanticipated Processes and Events" are two categories of processes and events which could occur within the "geologic setting" during the period after permanent closure of the repository. Determination of these categories of processes and events is required because:

(1) "Anticipated processes and events" are the primary design basis processes and events for the design of the waste package and the engineered barrier; and

(2) "Anticipated processes and events" together with "unanticipated processes and events" are to provide the basis for analysis to determine compliance with the overall system performance objective of 10 CFR Section 60.112 (implementation of the environmental standard promulgated by the U.S. Environmental Protection Agency (EPA) in 40 CFR Part 191). (See Ref. 1.)

It cannot be determined if the natural barriers, waste package, or engineered barrier system will comply with the required performance objectives of 10 CFR Part 60 until the "anticipated processes and events" and "unanticipated processes and events" have been determined. Therefore, any delay during licensing in identifying these processes and events will delay all subsequent proceedings, and any substantial delay in identifying the processes and events may prevent the U.S. Nuclear Regulatory

Commission (NRC), the U.S. Department of Energy (DOE), and affected States and tribes from fulfilling their obligations under the Nuclear Waste Policy Act (NWPA) (see Ref. 2.), within the mandated timeframe.

The primary concern which drives this request for rulemaking is that DOE intends to use primarily probabilistic methods to establish the various "anticipated processes and events" and "unanticipated processes and events." The NRC staff considers this inappropriate and contrary to the intent of the rule. The staff, therefore, is reiterating and clarifying the primarily deterministic methodology which it believes was intended during the promulgation of 10 CFR Part 60. The staff's concern that DOE is using an unacceptable interpretation of what constitutes "anticipated processes and events" and "unanticipated processes and events" is derived from several interactions with DOE, including:

(1) The NRC/DOE meeting on Seismic/Tectonics Investigations, December 3-4, 1985 (see Ref. 3.), in which DOE presented a proposed probabilistic methodology to categorize the various processes and events which could occur after permanent closure. The NRC staff criticized the methodology proposed by DOE and provided suggestions which the NRC staff believed DOE should incorporate. After this meeting, the NRC staff began work on a Generic Technical Position (GTP), to address concerns raised and provide needed guidance.

(2) The review of the Consultation Draft Site Characterization Plan (CDSCP) prepared by DOE. During the review of this document, NRC staff determined that DOE was continuing to use the same procedure which the NRC staff had previously criticized.

(3) Comments on the draft GTP. On February 29, 1988, the NRC staff published the draft GTP entitled "Guidance for Determination of Anticipated Processes and Events and Unanticipated Processes and Events." (See Ref. 4.) This draft GTP outlined the staff's

recommendations on how these terms should be implemented. Although many of the public comments on the draft GTP were supportive, several comments received, including comments from DOE, presented opposition to some of the methodologies suggested, from both a philosophical and regulatory viewpoint.

The staff considers that the position presented within the draft GTP is a technically sound and a reasonably conservative method of implementing those portions of 10 CFR Part 60 which deal with "anticipated" and "unanticipated" processes and events. The staff does recognize, however, that the wording of the rule is ambiguous and difficult to understand, and that the possibility exists that the licensing process could be seriously delayed, without modification of the rule, while the licensing board attempts to sort out the correct interpretation of the definitions of "anticipated processes and events" and "unanticipated processes and events." Therefore, the staff needs management policy decisions on whether rulemaking should proceed on this subject and on whether the direction the staff recommends will be supported.

2. HOW THE ISSUES WILL BE ADDRESSED THROUGH RULEMAKING

Section 4 of Attachment 2 presents a draft of the proposed rule modification, whereas Sections 2 and 3 present the technical bases for the structure and thrust of the rule change. The changes recommended would:

(1) make the rule more prescriptive, regarding deterministic methods;

(2) modify the definition of the term "geologic setting" in Section 60.2 and the section of the rule describing the underlying concepts of the term (Section 60.102);

(3) stipulate that certain human-induced processes and events be considered in the design and analyses of the waste package and engineered barrier system; and

(4) clarify the use of the terms "anticipated processes and events" and "unanticipated processes and events" within the context of the performance objectives of 10 CFR Part 60.

The following sections (2.1 to 2.4) present the four areas of concern which the rulemaking would be address, the specific questions to be resolved in each area, the option the staff recommends to resolve each question, and the other technical options that the staff has considered and rejected. Also, listed for reference, are the sections of Attachment 2 that provide discussions of the bases for the proposed resolution.

2.1 Changes to Make the Rule More Prescriptive for Deterministic Methods

(a) Should the terms "anticipated processes and events" and "unanticipated processes and events" be implemented using deterministic or probabilistic criteria? (See Sections 2.1, 2.2, 2.3 and 2.4 of Attachment 2.)

The draft GTP presented a deterministic methodology for selection and categorization of "anticipated processes and events" and "unanticipated processes and events." A number of comments on the draft GTP disagreed with the proposed interpretations, stating that the terms themselves were probabilistic. The staff considers that a deterministic methodology provides a sound technical basis for implementation of the rule and, based upon its review of the statement of considerations for the final rule, 10 CFR Part 60, is in keeping with the original intent. Furthermore, the staff considers that the primarily deterministic methods of implementation are in agreement with established NRC licensing procedures.

(b) Should the Quaternary Period be used as the period of reference for establishing the processes and events? (See Section 2.5 of Attachment 2.)

Closely allied with clarification of the need for use of deterministic criteria for selection of "anticipated processes and events" and "unanticipated processes and events" is the need to clarify and reaffirm the time period of reference for making both deterministic and probabilistic evaluations. Some of the comments on the draft GTP suggested the use of much shorter time periods than the staff considers feasible. After review of both the rule and the statement of considerations, the staff considers that use of the Quaternary Period (approximately the last 1.65 million years) as the primary period of record for selection of "anticipated processes and events" and "unanticipated processes and events" is both technically sound and reasonably conservative. The staff also recognizes, however, that use of a longer time period will, in some cases, be needed in evaluation of "unanticipated processes and events", and that changes in geologic processes and events through time must be factored into the evaluations. The staff has considered the use of shorter time periods such as the Holocene Epoch (approximately the last 10,000 years). Although the staff considers that processes and events which occurred during the Holocene Epoch must be factored into the evaluations, such a timeframe is too short to provide an acceptable basis for long-term extrapolation of naturally occurring processes and events.

2.2 Changes to Modify the Definition and Underlying Concepts of the Term "Geologic Setting"

(a) What are the intent and concepts underlying the term "geologic setting? (See Section 2.7 of Attachment 2.)

The definition of geologic setting within Section 60.2, along with the implementation paragraph of 10 CFR Section 60.102(c), allows several interpretations as to the extent of geologic setting. The present wording of 10 CFR Section 60.102 may allow the extent of the geologic setting to be represented as a summation of all the various components, a situation the staff considers to be technically unjustified. The staff considers that each component system should be evaluated separately, based on its own merits. The staff also is suggesting a minor modification to the definition -- substituting the term "natural" for geologic, hydrologic and geochemical. Although this substitution actually makes the rule less specific, it allows all component systems, including those controlling climate and mineral resources, to be evaluated separately, using the technical information considered appropriate for that component system. The staff did not consider that a Technical Position would resolve the concern.

2.3 Changes to Stipulate That Certain Human-Induced Processes and Events Be Considered in the Design and Analysis of the Waste Package and Engineered Barrier System

(a) Should certain human-induced processes and events be considered in the design and analysis of the waste package and engineered barrier system? (See Section 2.6.2 of Attachment 2.)

In the current rule, the definition of "anticipated processes and events" specifically excludes consideration of human-induced processes and events; however, such processes and events are to be considered under "unanticipated processes and events." This was a conscious decision by the Commission during the promulgation of 10 CFR Part 60 to try to assure that highly speculative scenarios do not dominate the licensing process. (See Ref. 5, p 28200.) Although the staff still agrees with this philosophy, the staff considers that certain human-induced processes and events--such as the greenhouse effect, weapons testing, and groundwater

pumpage--should be included in the design and analysis of the waste package and the engineered barrier system. Therefore, the staff is recommending a modification of Section 60.113(c) to stipulate that such processes and events be included in the design and analysis of the waste package and engineered barrier system for the site at Yucca Mountain. The staff specifically has not suggested that this be included in a modification of the definition of anticipated processes and events, to limit the speculative types of processes and events which might otherwise be considered. The staff also considered addressing the matter of human-induced processes and events by means of a Technical Position, but concluded that it would be too subject to contention, during the licensing process, to make this option viable.

(b) What effect should the presence of natural resources have on the required performance assessment assumptions? (See Section 2.6.1 of Attachment 2.)

The staff continues to consider that the act of direct human intrusion into the repository should be considered under "unanticipated processes and events" and see no need to revise the rule in this area. The staff does recognize that the likelihood and potential effect of drilling could be substantial in areas with high mineral resource potential and has presented guidance in the draft statement of consideration for the proposed rule change (Section 2.6.1 of Attachment 2) which provides a measure as to the quantity of direct intrusion which should be considered. As the staff recognizes that other considerations, such as the thermal pulse, may affect this evaluation, the staff does not consider that this guidance on the quantity of direct intrusion should be mandatory.

2.4 Changes to Clarify How "Anticipated Processes and Events" and "Unanticipated Processes and Events" Will Be Used in Evaluating Compliance with the Performance Objectives

In addition to changes to the rule, to clarify the definitions, the NRC staff would be using the rulemaking to clarify issues related to the use of the terms "anticipated processes and events" and "unanticipated processes and events," including:

(a) relationship of NRC (10 CFR Part 60) terms and EPA (40 CFR Part 191) terms;

(b) clarification of intent of 10 CFR Section 60.113(b); and

(c) clarification of intent of 10 CFR Section 60.113(c).

The following provides a discussion of these proposed changes.

(a) What is the relationship of the NRC terms "anticipated processes and events" and "unanticipated processes and events" to the terms used by EPA, specifically "undisturbed performance" and "all significant processes and events?" (See Section 2.8 of Attachment 2.)

After EPA promulgated 40 CFR part 191, the NRC published proposed conforming amendments to 10 CFR Part 60, for public comment, in the Federal Register, Vol. 51, No. 118, June 19, 1986 (See Ref. 6.) Because the standard was challenged in the Courts, work on the conforming amendment was put in abeyance. However, for much of the ongoing work of DOE and NRC, it has been necessary to assume that the primary section of 40 CFR Part 191 dealing with overall system performance will remain essentially unchanged. In the public comments on the draft GTP (Ref. 4.) this was an area in which many questions were raised. In the draft

conforming amendments the NRC stated that it considered that "anticipated processes and events" and "undisturbed performance" equated to similar conditions. The staff continues to hold this position and the proposed modifications to the rule do not change this concept. In the aforementioned Ref. 6, the NRC further stated that it equated "all significant processes and events" to all "anticipated" and "unanticipated" processes and events. The staff has reconsidered this statement and does not consider that this should be the exact relationship between the various terms. The NRC staff considers that "anticipated processes and events" and "unanticipated processes and events" should be selected using deterministic criteria, after which such processes and events must be evaluated to determine their significance. As EPA terminology of "all significant processes and events" not only requires probabilistic criteria, but also requires an assessment of the significance of the effect of the various processes and events (consequence analysis) before selection, the NRC staff does not consider that the NRC and EPA terms are directly equal. The staff considers that the correct relationship between the terms of the two agencies would be one in which the summation of all "anticipated processes and events" and "unanticipated processes and events" would include processes and events which have a lower or equal probability of occurrence than those processes and events included in the EPA "all significant processes and events." The resultant "anticipated processes and events" and "unanticipated processes and events" should then be evaluated, using criteria such as are presented in 10 CFR Section 60.122(a)(2), to determine which processes and events are to be included in "all significant processes and events." The proposed rule modification would clarify this concept.

The staff recognizes that other modifications to 10 CFR Part 60 will have to be undertaken when the revised EPA standard is promulgated, including modifications of 10 CFR Section 60.112 and portions of 10 CFR Section 60.21. The staff considers that, at this time, the NRC should clarify those portions of the interrelationship which can be accomplished before

promulgation of the final EPA standard. Uncertainties which still remain, at that time, will be resolved by the conforming rulemaking. This includes the possible adoption of identical terms, to the extent practical.

(b) What additional requirements are intended by 10 CFR Section 60.113(c)? (See Subsection 3.3 of Attachment 2.)

This proposed modification to 10 CFR Section 60.113(c) is intended to clarify the Commission intent regarding some of the additional requirements which may be imposed on the design of the waste package and engineered barrier system, if the Commission does not have reasonable assurance that the overall system performance objective can be met without these additional requirements. Although the staff recognizes that this change could also be accomplished by a Technical Position or through the statement of considerations, the staff prefers the rulemaking option.

(c) Under what conditions can the performance objectives presented in 10 CFR Section 60.113(a) be modified? (See Section 3.4 of Attachment 2.)

Although 10 CFR Section 60.113(c) allows the Commission to modify the design basis for the waste package and engineered barrier system, 10 CFR Section 60.113(b) allows the Commission to modify and possibly set aside the performance objectives presented in 10 CFR Section 60.113(a) provided the overall system performance objective has been met. Based on review of both the rule and the statement of considerations for the final 10 CFR Part 60, the staff considers that the phrase "as it relates to anticipated processes and events" should be removed from 10 CFR Section 60.113(b). The primary basis for removal of this phrase is to emphasize and clarify the fact that the overall system performance objective depends on both "anticipated processes and events" and "unanticipated processes and events." The wording change should more clearly state the requirements and intent of the rule.

3. THE NEED FOR RULEMAKING

3.1 Need

Due to the ambiguity present within those portions of 10 CFR Part 60 dealing with "anticipated processes and events" and "unanticipated processes and events," the staff is concerned that unless the rule more specifically states those processes and events which should be considered within the two categories, potentially serious delays could occur during the licensing processes, such that the NRC could not fulfill its obligations to come to a licensing decision during the NWPA mandated time-frame.

In addition to the concerns related to delay of the licensing process, it is known that DOE is presently undertaking and planning design, analysis and testing of the site and the various proposed engineered components. If the DOE program is focused on a set of processes and events different from those which the staff believes necessary for licensing, the possibility exists that the DOE program may be misdirected, resulting in needless expenditures in gathering information which may not meet the regulatory requirements.

3.2 Urgency

The major concern of the staff is that, without modification of the rule, the licensing process could be seriously delayed while the Licensing Board tries to sort out the correct interpretation of the definitions of "anticipated processes and events" and "unanticipated processes and events." Based on discussions with DOE, the staff has been informed that DOE will need final clarification of this definition and other concerns at least two years before the license application submittal, to assure that they become factored into the licensing documents. Assuming DOE's present schedule, this would require having the modified definitions in place

during 1992. Assuming the standard two-year period to promulgate a rule change, and allowing for a six to nine month period to obtain approval from the Executive Director for Operations (EDO) to initiate the rule change, work must start on this rule modification in 1989.

4. POSSIBLE ALTERNATIVES TO RULEMAKING

In addition to the possibility of rulemaking, two other alternatives exist for providing DOE with guidance on implementation of the terms "anticipated processes and events" and "unanticipated processes and events." They are completion of a Technical Position, or providing no guidance, and allowing the resolution of these concerns to wait until the licensing hearings.

The preferred option of rulemaking is suggested, as such action will provide definitive guidance in the area of human-induced processes and events, the extent of the geologic setting, and the methodology to determine both anticipated and unanticipated processes and events. By doing so, the Licensing Board will have a much clearer understanding of the requirements of the rule. Thus, the possibility of delay of the licensing process would be reduced.

The option of providing the guidance through a Technical Position exists. However, it is considered unlikely that DOE will completely agree on the meaning and intent of the terms, even with a Technical Position and associated public meetings. As the rule is presently structured, the staff recognizes that several options could be suggested for clarifying these terms. Even if it becomes possible to reach agreement with DOE, the possibility exists that the Licensing Board may not accept interpretation, especially in the area of treatment of human-induced processes and events and definition of the geologic setting.

The staff does not consider that the "no action" alternative is in the best interest of the overall program.

5. EFFECTS

The proposed rule change will have no direct effect on the public, since the rule modification is for clarification and streamlining of the licensing process, not for improving public health and safety. The effects on DOE and industry should be minimal. Although the rule modification may require consideration of more processes and events during the design and analysis phase than DOE is presently planning, the overall effect should be to make the DOE task less complex, as a major area of regulatory uncertainty would be lessened. The major effect will be on the NRC and the Licensing Board, and the effect should be positive. The structure of the proposed rule modification should help assure that the licensing process will proceed in an orderly fashion and help to assure that the licensing process can be completed during the NWPA-mandated timeframe.

6. SCHEDULE AND RESOURCES

As most of the effort on this proposed rulemaking package has been completed during the development of the draft GTP, we anticipate that both the time and resources necessary to complete this rulemaking should be less than that which would be used assuming standard planning factors. We also do not see the need for contractor support. However, the Center for Nuclear Waste Regulatory Analysis should be made fully cognizant of this effort as it develops the program architecture for the NRC High-Level Waste program.

Anticipated resources:	FY89	1 FTE
	FY90	1 FTE

Our anticipated schedule assumes that an Advance Notice of Proposed Rulemaking does not need to be issued. The reason for this assumption is that the proposed rule modification is based on the draft GTP which has already undergone a public comment period. Based on this assumption, our tentative schedule is approximately 24 weeks less in duration than one which would be obtained using standard planning factors. The anticipated schedule is as follows:

January 1989	Director, Division of High-Level Waste Management approval
July 1989	EDO Approval to start rulemaking
October 1989	Proposed rule for Division review
January 1990	Office concurrence on proposed rule completed
March 1990	Proposed rule package to EDO
July 1990	Proposed rule published
January 1991	Final rule published

Detailed milestone will be provided later.

REFERENCES

1.. U.S. Environmental Protection Agency, "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes", Federal Register, Vol. 50, No. 182, Sept 19, 1985, 38066-38089.

2. "Nuclear Waste Policy Act of 1982," House Resolution 3809, (as Amended by House Resolution 3545, 1987), 97th Congress, 2nd Session, January, 1982.

3. U.S. Nuclear Regulatory Commission/U.S. Department of Energy, "Summary of NRC/DOE Meeting on Seismic/Tectonic Investigations," in Silver Spring, Maryland, December 3-4, 1985.

4. U.S. Nuclear Regulatory Commission, "Draft Generic Technical Position entitled ""Guidance for Determination of Anticipated Processes and Events and Unanticipated Processes and Events," Notice of availability in Federal Register, Vol. 53, No. 39, February 29, 1988, 6040.

5. U.S. Nuclear Regulatory Commission, "Disposal of High-Level Radioactive Wastes in Geologic Repositories, Technical Criteria," Federal Register, Vol.48, No.120, June 21, 1983, 28194-28229.

6. U.S. Nuclear Regulatory Commission, "Disposal of High-Level Radioactive Wastes in Geologic Repositories; Conforming Amendments," Federal Register, Vol. 51, No. 118, June 19, 1986, 22288-22301.

Document Name:
ATTACHMENT 2.

Requestor's ID:
TRAPP

Author's Name:

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DRAFT OF PROPOSED RULMAKING PACKAGE

1. BACKGROUND

On February 29, 1988, the Commission published for public comment a draft generic technical position (GTP) titled "Guidance for Determination of Anticipated Processes and Events and Unanticipated Processes and Events." (See Ref. 1.) Based both on the comments received, and programmatic decisions by the Commission, it has been decided that this draft GTP will not be finalized. Instead, it has been determined that the concerns which caused the Commission to initiate the draft GTP can best be resolved through modification of 10 CFR Part 60. The following describes the changes contained within the proposed rule modification, and the basis for the changes. Since the wording of the changes has been strongly influenced by the public comments received on the draft GTP, a discussion of these comments will be included, as appropriate.

2. BASIS FOR PROPOSED RULE MODIFICATION

2.1 Use of Deterministic and Probabilistic Criteria

Comments on the draft GTP tended to reflect the spectrum of opinion of the scientific community on the merits of "deterministic" techniques versus "probabilistic" techniques for selecting and categorizing various processes and events into "anticipated processes and events" and "unanticipated processes and events."

The U.S. Nuclear Regulatory Commission (NRC) considers that a deterministic scientific understanding of the processes and events should be the primary consideration for the selection of processes and events, and not a selection based primarily on probabilities. This has been a long-standing NRC practice concerning the application of probabilities in licensing actions. For example, during the promulgation of 10 CFR Part 60, the Commission recognized that many public comments on the proposed rule were suggesting probabilistic bases for

classifying processes and events as anticipated processes and events, and unanticipated processes and events. The Commission, however, rejected this approach, observing, "Identification of anticipated and unanticipated processes and events for a particular site will require considerable judgement and will not be amenable to accurate quantification, by statistical analysis, of their probability of occurrence." Further, it was noted that "There can only be estimates rather than rigorous demonstrations of probabilities of occurrence." (See Ref. 2.)

The Commission continues to hold this view, i.e., that the probability of most natural processes and events cannot be quantified in a rigorous way, primarily due to the subjective nature of much of the input data. This does not mean, however, that the Commission will not consider the results of probabilistic analyses. The Commission strongly believes in using both deterministic and probabilistic techniques in both the design and analysis of a high-level waste repository.

As stated on page 6 of the draft GTP, "The staff will need to use professional judgement in considering the available scientific information" regarding classification of processes and events. The Commission recognizes that some of the scientific information will be presented in probabilistic terms. The weight the Commission would put on such information would be in direct proportion to the quality of the basic data underlying such analyses and the general acceptance by the scientific community of the procedures used.

Because the containment requirements of 40 CFR Section 191.13 are expressed as probabilistic standards, and because the Commission has concurred in the issuance of 40 CFR Part 191, the NRC recognizes the need to use probabilistic techniques. Although the Commission recognizes that the resultant analysis to determine compliance with 40 CFR Section 191.13 is a probabilistic analysis, the Commission also recognizes that the processes and events to be considered could be initially selected based on either probabilistic or deterministic criteria. In other words, the processes and events could be selected based on

some probabilistic cut off, or deterministic criteria could be selected to establish "anticipated processes and events" and "unanticipated processes and events," from which the U.S. Environmental Protection Agency (EPA) "significant processes and events" could be selected. The Commission considers that the latter approach should be used.

2.2 Implied Probability of Terms

Many comments on the draft GTP discussed the "implied probability" of the phrases "anticipated processes and events" and "unanticipated processes and events." Although the Commission has recognized that there are some implied qualitative probabilistic connotations within the definitions of the terms "anticipated processes and events" and "unanticipated processes and events," the staff interprets the implied probability connotation in light of the Quaternary record (see Section 2.5). To evaluate the effects of the implied probability connotations, the staff has compared the relative hazard implied by the various criteria for other nuclear facilities, such as that presented in Appendix A to 10 CFR Part 100, to the implied probability which would be obtained by using the criteria which were presented in the draft GTP and as is presented in this proposed rule modification. If it is assumed that the processes and events could be evaluated on a primarily probabilistic basis, the use of the recurrence of a Quaternary event as an anticipated event implies a probability between 10E-6 and 10E-7 per year (one chance in approximately 1,600,000), as an approximate cut off for anticipated processes and events. In Appendix A of 10 CFR Part 100, where criteria are stated deterministically, the criterion of "more than once in 500,000 years" gives an implied probability on the order of 10E-5 to 10E-6 per year (no more than one in 5000,000). Although this seems to indicate a more stringent criterion for 10 CFR Part 60 facilities, if both the Appendix A criteria and 10 CFR 60 criteria are converted to hazard per period of exposure, the Appendix A type facilities normally have a life time expectancy of less than 50 years, which gives an implied probability of exceedence during the life of the facility of on the order of 10E-4 to 10E-5 (on the order of one chance in 10,000). The minimum

period of performance under 10 CFR 60 during the period following permanent closure is 300 years which converts to an implied probability of exceedence in the range of 10E-3 to 10E-4 (approximately one chance in 5000), while if a 10,000 year period is used, the implied probability of exceedence during this period is on the order of 10E-2 to 10E-3 (approximately one chance in 160). As a repository is a relatively passive facility in comparison to such facilities as nuclear power plants, the relative relationship of hazard of the two types of facilities is considered appropriate.

As an additional consideration, the relative probability of "anticipated processes and events" selected as outlined within this proposed rule modification, can be compared to the probabilities presented within the vacated EPA Standard, 40 CFR Part 191 (Ref. 3.). Such a comparison shows that anticipated processes and events would have a higher probability of occurrence than those which 40 CFR part 191, Appendix B, stated did not need to be included in the analysis (one chance in 10,000 in 10,000 years or approximately 10E-8 per year). Anticipated processes and events would also have a higher probability of occurring than processes and events which would have been considered in evaluating all significant processes and events (one chance in 1000 per 10,000 years or approximately 10E-7 per year (40 CFR Section 191.13(a)(2)). These implied probabilities are in line with the statement of considerations for the final rule 10 CFR Part 60 in which the contradiction between the requirements imposed by "anticipated processes and events" and the requirements of the proposed EPA Standard were resolved by defining "unanticipated processes and events." (See Federal Register, Vol 48, No. 120, June 21, 1983, p. 28200, Ref. 2.)

2.3 Use of the Terms "Anticipated Processes and Events" and "Unanticipated Processes and Events" Versus the Terms "Anticipated" and "Unanticipated"

Although the phrases "anticipated processes and events" and "unanticipated processes and events" are regulatory terms, many comments on the draft GTP used the terms anticipated and unanticipated as defined within a dictionary. This

was one recognized reason for the differences in interpretations of the implied probability connotations of the various phrases. As stated in one comment, "The use of Anticipated and Unanticipated to denote classifications of events and processes seems unusually obscure." Such comments indicated that the present wording of the rule itself tends to obscure the primary function of the terms; to assure that the processes and events used for design and analysis for the period after permanent closure are sufficient to provide reasonable assurance that the public health and safety can be protected. One of the primary functions of the suggested rule modification is to clarify the use of these terms. The Commission has considered using new terms or phrases which better reflect the intended use; however, there is a strong interrelationship between the terms "anticipated processes and events," "unanticipated processes and events" and the EPA terminology. Therefore, the Commission has decided that terminology modifications should not be considered until the remanded EPA Standard (40 CFR Part 191) has been finalized. When the NRC prepares the conforming rule modifications to allow implementation of the finalized EPA Standard, the potential for change in terminology will again be considered.

2.4 Better Quantification of Definitions

Some of the comments received on the draft GTP suggested that the terms "reasonably likely" and "not reasonably likely but sufficiently credible to warrant consideration" should be better quantified, or presented interpretations quantifying these terms. Although the concept intended by these phrases is retained, these exact phrases have been removed from the definitions, and the resulting definitions more explicitly state what processes and events the Commission considers these terms imply within each classification.

2.5 Use of Quaternary

When using "deterministic" criteria to select and categorize "anticipated processes and events" and "unanticipated processes and events," it is necessary

to define the required period of record for implementation of the criteria. The Commission has used, and is continuing to use, the Quaternary Period record.

Comments on the draft GTP about the use of the Quaternary Period, with emphasis on the late Quaternary Period/Holocene Epoch, as the basis for the selection of anticipated processes and events and unanticipated processes and events, ranged from those that indicated the NRC position was correct, to those that stated that the time was much too long. Some commentators also stated that implementation of the rule, as stated within the draft GTP, might be overly conservative. Several commentators questioned the exact intent of the NRC, especially as related to required modeling, or to sites which have a poorly defined Quaternary record. The proposed changes to the rule are meant to better define the intended use of information gained from the Quaternary record.

Within 10 CFR Part 60, there are many implicit and explicit requirements for consideration of Quaternary processes and events. For example, the requirement for consideration of the Quaternary Period was included within the basic definition of anticipated processes and events. Another area of the rule which has been quite explicit regarding the use of the Quaternary is within the siting conditions of Section 60.122. In addition, as was stated in the Federal Register, Vol. 48, No. 120, June 21, 1983, p.28200, (See Ref. 2.), the considerations of unanticipated processes and events ".... include processes and events which are not evidenced during the Quaternary Period or which, though evidenced during the Quaternary Period are not likely to occur during the relevant time frame." The Commission considers that the Quaternary record, especially the late Quaternary/Holocene record, should provide the primary basis in determining post-closure design basis processes and events and post-closure system performance basis processes and events. The Commission considers, however, that the Holocene, by itself, provides too short a history to draw tightly constrained conclusions about future processes and events. For example, at the Yucca Mountain Project site, some faults for which recurrence

intervals have been estimated have recurrence intervals ranging from 10,000 to 100,000 years, have demonstrated multiple movements during the Quaternary, even though most have no verified Holocene movement, and are oriented in the present stress field such that movement could occur. Consideration of only the Holocene record could eliminate many of these faults from consideration for design and analysis, a condition the NRC would consider unacceptable.

Although the concept of consideration of Quaternary processes and events is a central theme within 10 CFR Part 60, the NRC recognizes that some processes or events which occurred within the Quaternary Period may be associated with a phenomenon that no longer operates within the geologic setting. Within the draft GTP, it was the intent of the staff to indicate that such processes and events would probably not need to be considered in design and analysis. For example, on page 6 of the draft GTP, the staff stated it would consider any changes in the processes or events which are evident in the Quaternary record. On page 12 and on page 15 of the draft GTP, the staff used the phrase "without geologic evidence to the contrary" to imply that this concept would be implemented. In addition, on page 15, the NRC staff provided an example in which it stated, "However, if it can be shown that there has been a fundamental change in the tectonic characteristics of the geologic setting such that it is not credible to use the entire record since the inception of the present stress regime, the data for events and processes prior to the change in the stress regime would be eliminated from consideration."

The question of whether a site has an "adequate" Quaternary record such that information is present to classify processes and events as either "anticipated processes and events" or "unanticipated processes and events" can only be resolved through site characterization. The basic requirements for site investigation and evaluation are perhaps best stated in Subsection 60.122(a)(2). Within this section of the rule, the U.S. Department of Energy (DOE) is required to: (1) demonstrate that the potentially adverse conditions have been adequately investigated, including the extent to which the condition may be present and still undetected; (2) show that the condition has been

adequately evaluated, using assumptions which will not underestimate the effects; and (3) show that the condition will not significantly affect waste isolation, or that the condition is compensated for by some combination of favorable conditions, such that the performance objectives are met, or demonstrate that the condition can be remedied. If the above can be demonstrated, even without an adequate record of the Quaternary Period, the site would probably be suitable for licensing.

If it is assumed that the final EPA Standard is similar to the vacated EPA Standard, the NRC not would require modeling beyond the 10,000 year period to determine overall site performance; however, neither NRC nor EPA would consider a site acceptable which could be shown to function adequately for 10,000 years, after which it allowed unrestricted release of radionuclide to the environment. For example, when the EPA promulgated 40 CFR Part 191 (See Ref. 3), it stated "There was no intent to indicate that times beyond 10,000 years were unimportant...." In addition, EPA assumed that the DOE guidelines (10 CFR Part 960 (reference 4)) had provisions for comparative evaluation of sites which would consider a 100,000 year timeframe. With the revision of the Nuclear Waste Policy Act (NWPA) (See Ref. 5) to concentrate on only one site, Yucca Mountain, it is unclear if any part of this provision of 10 CFR Part 960 directly applies. It should be noted, however, that within 10 CFR 60, the requirements for restricted release from the engineered barrier system are not limited to the first 10,000 years after permanent closure.

In addition to the Quaternary record itself, on page 6 of the draft GTP, the staff listed several other factors which would be used to help determine both "anticipated" and "unanticipated" processes and events. Normally those processes which occurred in the geologic setting before the Quaternary Period would have been used to help define unanticipated processes and events. In other words, those factors would normally not change the design requirements, but could add processes and events which would be required for consideration in development of the processes and events to be analyzed in determining compliance with 40 CFR Section 191.13, as implemented in 10 CFR Section 60.112.

It is the intent of the Commission that the proposed wording change in the rule should clarify this concept.

2.6 Human-Induced Processes and Events

Many comments on the draft GTP discussed human-induced processes and events. Most comments agreed that human-induced processes or events--the anthropological influence--must be accounted for in the design and analysis. However, a number of comments, such as DOE's, suggested that the wording of 10 CFR Part 60 did not allow such processes and events to be classified as anticipated processes and events.

During the promulgation of 40 CFR Part 191 and 10 CFR Part 60, both the EPA and the NRC, respectively, concentrated on "inadvertent human intrusion" into the repository, and largely ignored other potential anthropological effects. Although the Commission considers that 10 CFR Part 60 allows sufficient flexibility to accommodate other human-induced processes and events, in addition to inadvertent human intrusion, through the provisions of Subsection 60.113(c), it also recognizes that rule modification is desirable to eliminate ambiguities prior to the licensing process.

2.6.1 Direct Human Intrusion

If direct human intrusion into the repository is first considered, as stated within the non-mandatory guidance within Appendix B to 40 CFR Part 191, EPA assumed that none of the active institutional controls would prevent or reduce radionuclide release for more than 100 years after disposal, and that as long as passive institutional controls endured and were understood, they could be effective in deterring systematic and persistent exploitation at the disposal site, and could reduce the likelihood of inadvertent intrusion. However, the EPA also stated that passive institutional controls could never be assumed to eliminate the chance of inadvertent human intrusion into the disposal site.

The NRC adopted the philosophy that the possibility of intrusion into the repository by drilling should be assumed, even in the presence of passive institutional controls, during the promulgation of 10 CFR Part 60. As was stated in the Federal Register, Vol. 48, No.120, June 1983, p. 28199 (Ref. 2)," ... the Commission is of the view that while the passive control measures it is requiring will reduce significantly the likelihood of inadvertent intrusion into a geologic repository, occasional penetration of the geologic repository over the period of isolation cannot be ruled out, and some provision should be made in the final rule for consideration of intrusion should these measures fail." As the most likely reason for such intrusion would be as a result of exploration of natural resources, the rule requires an evaluation of natural resource potential to determine the relative desirability of drilling within the controlled area versus other parts of the geologic setting. Because there will be passive institutional controls, the Commission determined that such intrusion should be classified as an unanticipated process or event. By classifying such activities as unanticipated, DOE would not be required to design the engineered barrier system and waste package to resist drilling activities. DOE would, however, have to evaluate the overall potential for such activities, based on the relative potential for natural resources to attract exploration activities within the area, and would have to determine its effect on meeting the overall requirements of 40 CFR Section 191.13 as implemented in 10 CFR Section 60.112. Nothing in the proposed rule modification changes this concept.

Several commentors questioned the suggested method of usage of Appendix B to 40 CFR Part 191, and many commentors stated that they thought that the NRC had to use the 40 CFR Part 191 Appendix B guidance. As stated above, the guidance presented in Appendix B to 40 CFR Part 191 is non-mandatory. As such, its use by the DOE and NRC is discretionary. Within the draft GTP, the NRC staff presented the position that if the potentially adverse condition of Subsection 60.122(c)(17) were not present, the staff considered that the amount of drilling specified within Appendix B to 40 CFR Part 191 was the amount of drilling which should be considered when evaluating compliance with overall

system performance. The staff did not consider that this was the maximum amount of drilling which could occur if potentially adverse condition Subsection 60.122(c)(17) were present, and therefore suggested that the drilling assumed should be based on an evaluation of the drilling history of other similar deposits, i.e., deposits which are as close an analogue as possible to the type of deposit which caused the potentially adverse condition to be considered to be present. The staff had therefore considered what was credible or not, and had suggested actions which were under the auspices of the NRC, and which would be in agreement with both 10 CFR Part 60 and 40 CFR Part 191. The Commission considers that this philosophy and logic would be correct when considering direct human intrusion into the repository. In addition, however, the Commission recognizes the long term thermal pulse which will be generated by the repository and considers that this, by itself, may cause future generations to recognize the presence of the repository and prevent potential inadvertent intrusion. The Commission considers that this factor also needs to be considered when evaluating the potential of inadvertent human intrusion into the repository.

2.6.2 Other Human-Induced Processes and Events

The Commission considers that the potential for other types of human-induced activities, aside from direct intrusion, should be considered on a case-by-case basis. As 10 CFR Part 60 is presently worded, passive institutional controls will be present within the controlled area, and the Commission considers that all human-induced activities within the controlled area or on land controlled by DOE in accordance with the provisions of 10 CFR Section 60.121(b) should be classified as an unanticipated process or event. This is in agreement with the original intent of 10 CFR Part 60.

The Commission recognizes, however, that other human-induced processes and events could occur after permanent closure outside the controlled area, and that some of these processes and events, such as climatic change due to the introduction of pollutants into the atmosphere, could have a significant effect

on the overall performance of the site. The Commission considers that such processes and events should be considered in the design of the engineered barrier system and waste package, in addition to being considered in determining compliance with the overall system performance objective.

In the current rule, the definition of "anticipated processes and events" specifically excludes consideration of human-induced processes and events; however, such processes and events are to be considered under "unanticipated processes and events." This was a conscious decision by the Commission during the promulgation of 10 CFR Part 60 to try to assure that highly speculative scenarios do not dominate the licensing process. (See Ref. 2, p. 28200.)

The Commission is still of the opinion that highly speculative scenarios should not be allowed to become the driving force in license reviews. To limit the types of processes and events which must be considered, the Commission has retained the limitations presented in unanticipated processes and events, and has not modified the definition of "anticipated processes and events" to include human-induced processes and events. The Commission has, instead, added specifications in Section 60.113(c) to require consideration of certain human-induced processes and events--namely weapons testing, groundwater pumpage, and climatic change--in the design and analysis of such things as the waste package and the engineered barrier system. The Commission considers that, for the design and analysis, these effects should be considered as realistic estimates which assume no significant loss in the knowledge base of the population, and assume that the governing institutions which are responsible for enforcing the pertinent laws and regulations retain continuity. For example, in the specific case of the Yucca Mountain site, nuclear weapons testing will most likely continue, and DOE should assume that there will be controls imposed by society on the type and amount of testing allowed, similar to the controls currently imposed.

2.7 Geologic Setting

Several commentors on the draft GTP questioned the geographic extent of the geologic setting and stated that a more prescriptive definition should be presented.

Within the present 10 CFR Part 60, the extent of the geologic setting can be interpreted to be a summation of the extent of the various systems. In other words, the geologic setting could be interpreted to be the combination of the relevant setting for tectonics, and the relevant setting for climate, plus any other relevant systems. Although the Commission agrees that this is an interpretation which could be made, the Commission does not consider that such an interpretation is appropriate from a regulatory perspective. If such an interpretation is made, the area of the geologic setting would most likely be controlled by the climatologic system. This could be interpreted to require investigations of a global scope. Within the draft GTP, the staff stated:

> "The definition of Geologic Setting in 10 CFR 60.2 discusses the 'systems of the region in which the geologic repository operations area is located.' For purposes of this GTP, the staff considers these systems as a regularly interacting or interdependent group of items forming a unified whole within the region of the geologic repository operations area, such as a ground water basin or an area of similar tectonic process. It will be necessary, therefore, to define which systems are relevant, and their geographic extent."

The staff therefore had considered that the geologic setting was comprised of various systems which were acting generally independent of one another. The staff considered that there should a separate geologic setting for each system. This is the usage of geologic setting which the Commission considers appropriate.

To further emphasize that geologic setting is a term which reflects various systems which must be considered separately, the Commission is making minor modifications to the definition and to the implementation paragraph. Within the definition, the term "natural" has been substituted for the terms "geologic, hydrologic, and geochemical." The reason for this change is to assure that systems such as those controlling climate and mineral resources are be considered. The paragraph of Section 60.102 which states the underlying concepts is also being modified to assure that the extent of each system that must be considered in exploration and analysis is being based on the possible effects of that system on waste isolation, and that each system is being considered on its own merits.

The Commission does not consider that it is appropriate to provide a more prescriptive definition of geologic setting as there will be various sizes of systems within the geologic setting based on the specific process or event being addressed. For example, the system which must be considered for volcanism will most likely be different than the system which must be considered for climate. Boundaries of the geologic settings for the various systems can only be defined after obtaining a thorough understanding of the various processes and events which have acted or are acting within the general region of the site. Since this understanding can only be obtained through site characterization, the boundary of the geologic setting, and the systems contained within, cannot be determined precisely until site characterization has been completed.

The Commission notes that the definition of "tectonic province" presented in Appendix A to 10 CFR Part 100 is more specific than geologic setting as presented in 10 CFR 60. The definition of "tectonic province" is consider by many to be outdated and needs to be revised. (See Ref. 6.) By focusing the analysis for 10 CFR Part 60 on the requirement that there be a sound technical basis for delineating each separate system within the geologic setting, the NRC hopes to avoid the problems which have arisen with the definition of tectonic province.

2.8 Relationship to EPA Standard

Many comments received on the draft GTP were directed at confirming the relationship of anticipated processes and events and unanticipated processes and events to the requirement that the NRC implement the EPA Standard. The EPA Standard has been vacated: however, much of the ongoing work at the DOE and NRC assumes that the overall system performance requirements of the final EPA Standard will be similar to the present EPA Standard. (See, for example, Ref. 7.) The following discussion is based on that assumption, with the recognition that if the assumption is not correct it will have to be modified during the rule modification associated with conforming Part 60 to the EPA standard.

Before the final 10 CFR Part 60 was promulgated, the EPA had published a draft of the proposed 40 CFR Part 191. Although the Commission recognized that there would be changes in the EPA Standard before finalization, it also was aware that the final containment standard would be of a probabilistic nature. Because of review of the draft 40 CFR Part 191, the NRC added the term "unanticipated processes and events" into 10 CFR Part 60. As was stated in the Federal Register Vol. 48, No. 120, June 21, 1983, p. 28200 (Ref. 2):

> "The Commission views the proposed EPA Standard as being directed to the evaluation of releases arising out of the categories that we have defined as "anticipated processes and events" and "unanticipated processes and events." As EPA itself recognizes, there can only be estimates rather than rigorous demonstrations of probabilities of occurrence. The Commission's translation of the EPA language into qualitative terms provides a clearer basis for judging, under the Atomic Energy Act, whether there is unreasonable risk to the health and safety of the public."

After the EPA published the final rule 40 CFR Part 191, the Commission began work on conforming amendments to 10 CFR Part 60, to provide for adoption of the EPA Standard. A draft revision was published for public comment in the Federal Register, Vol. 51, No. 118, June 1986 (See Ref. 8.). Within this draft, the

NRC provided explanations of the relationship of the various terms contained within 10 CFR Part 60 to terms within 40 CFR Part 191, and also provided explanations of how the containment requirement of 40 CFR Part 191.13 would be implemented. The recommended procedure used the methodology outlined in NUREG/CR-4510 (Ref. 7).

Although exact answers to many questions raised in comments on the draft GTP regarding implementation of the EPA standard cannot be given at this time, the staff believes that the final 40 CFR Part 191 will still have a containment requirement which is probabilistic in nature. It is further being assumed that 40 CFR Section 191.13 will retain the majority of the requirements contained within the vacated EPA Standard. As such, the Commission considers that it will still be necessary to consider all "significant processes and events," in determining compliance with the EPA containment requirements. Thus, it would be necessary to assign probabilities to determine "all significant processes and events." The Commission intends that these probabilities be assigned <u>after</u> "anticipated processes and events," and "unanticipated processes and events" have been selected and categorized, but <u>before</u> being used to determine "all significant processes and events" to determine compliance with the EPA containment requirements. The requirement for assignment of numerical probability estimates is imposed by the EPA through the formulation of 40 CFR Part 191 only as regards the containment standard. Even though the NRC considers that such numerical probabilities are highly subjective, the NRC will implement the standard as promulgated by EPA. The form of the EPA Standard does not preclude the NRC from implementing its own regulations, using an approach which does not require the assignment of numerical probabilities to select the processes and events which must be subjected to further study and analysis. This basic philosophy has been stated by the NRC a number of times. For example, after the publication of the final EPA Standard (subsequently vacated), when the Commission published the draft conforming amendments (<u>Federal Register</u>, Vol 51, No. 118, June 19, 1986, p.22291 (Ref. 8)) it stated:

"The Commission will require an extensive and thorough identification of relevant processes and events, but will require analysis of the probability and/or consequence of each only to the extent necessary to determine its contribution to the overall probability distribution. If it can be shown, for example, that the particular event is so unlikely to occur that its effects on the probability distribution would not be meaningful, further analysis of the consequences of the event would not be required."

For purposes of performing analyses to determine compliance with the overall containment requirement of the EPA Standard, as presently outlined in the vacated Standard, the Commission wishes to assure that "all significant processes and events" that may affect the disposal system" are contained within the summation of anticipated processes and events and unanticipated processes and events. The Commission recognizes that some of the unanticipated processes and events may not have to be included to determine compliance with the EPA Standard, due to the low probability of occurrence of these processes and events, and considers this an appropriate position from both a regulatory and scientific standpoint. From a scientific standpoint, the Commission recognizes the large uncertainty that is present in evaluating extreme events, along with the large effect such values can have on various calculations. From the regulatory standpoint, the Commission recognizes the possibility that many previously unidentified scenarios could be introduced during the hearing process. The Commission considers it prudent that the site characterization activities of the DOE be sufficiently inclusive to assure that a bounding group of processes and events--both in terms of probability and consequences--have been considered by DOE before the hearing process begins, to assure that such scenarios can be considered without introducing major delay.

3. REGULATORY ANALYSIS

The following presents a line-by-line commentary on the proposed rule change. The reader will find the complete line-in, line-out text of the proposed rule change in Section 4.0.

3.1 Section 60.2--Definition of "Anticipated Processes and Events"

"Anticipated Processes and Events" are natural processes and events which may occur in the geologic setting during the period following permanent closure which have the following characteristics:

The phrase "reasonably likely to occur" along with the phrase "to the extent reasonable in light of the geologic record," have been removed from the definitions, as the rule more specifically states those types of processes and events which must be considered in determining "anticipated processes and events," along with the considerations needed to evaluate the Quaternary record.

(a) "Anticipated Processes" are described by a conservative projection of the average rate of the process under consideration based on an analysis of the nature and rate of the process during the Quaternary Period and consideration of the spatial and temporal variability of the process.

The term "conservative projection" is intended to signify that the anticipated processes and events must be selected so as to assure that the requirements of Section 60.122(a)(2) have been met.

The Commission considers that selection of the anticipated processes and events should be based on the best estimate of the projected rate of the process being considered after a thorough analysis of the Quaternary record. The projection of the processes during the period after permanent closure should also recognize the cyclic or episodic nature, both in space and time, of various

processes. If there has been a fundamental change in the process, such that it can be demonstrated that the late Quaternary/Holocene record of the process is significantly different from the record of the process during the entire Quaternary Period, the process characteristics selected should reflect this fundamental change. See discussion above on use of the Quaternary.

(b) "Anticipated Events" are events similar in characteristics to events which occurred during the Quaternary Period. Such events should be assumed to occur at locations controlled by, or which evolve from, processes and mechanisms which controlled the Quaternary event. The characteristics of an event may be modified if analysis of the processes which are manifested by the event warrants such modification.

The Commission considers that the anticipated processes and events should, in general, be assumed to be a recurrence of the events which affected the geologic setting during the Quaternary Period. The Commission recognizes that some of the events which occurred during the Quaternary will have well-defined controlling processes and mechanisms, which limit the locations in which they can occur, while many will not. When the controlling mechanism and process can be defined, the event should be assumed to occur at a location where that specific controlling mechanism or process has been or is operating. The Commission also recognizes that there will be cases ranging from instances in which the controlling mechanism or process is poorly defined to cases in which the event is either a true random event or one which is best handled as a random event. The locations of the anticipated processes and events should therefore be assumed, based on the demonstrated knowledge of the understanding of the controlling process. As an event is simply the manifestation of some process, characteristics of an event reflect the characteristics of the process, and if the characteristics of the process have changed during the Quaternary, the characteristics of the event should reflect this change. In general, however, the Commission considers that knowledge of the underlying

processes is such that, without geologic evidence to the contrary, the Quaternary events should be assumed to occur during the period of performance.

"Anticipated Processes and Events" must take into account the perturbations caused by the presence of emplaced radioactive waste.

Although the anticipated processes and events are external to the engineered barrier system, the Commission recognizes that the characteristics of the engineered barrier system of the geologic repository will interact with the anticipated processes and events, and when performing the analysis, the DOE must account for this interaction. The waste package analysis, for example, must consider the anticipated processes and events, such as the geochemical conditions of the rock and groundwater of the geologic setting in the design and analysis. Corrosion of the waste package may occur under these conditions, and it, in turn, is a perturbation which may modify the natural geochemical conditions surrounding the waste package. Corrosion is, however, not an anticipated process and event, but is a result of anticipated processes and events. In analyzing the effects of corrosion, the DOE must demonstrate that, assuming the anticipated processes and events and the interactions of the waste package with the anticipated processes and events, the amount and type of corrosion expected will not prevent the Commission from making a finding of reasonable assurance that the waste package can meet the required performance objective.

3.2 Section 60.2--Definition of "Unanticipated Processes and Events"

"Unanticipated Processes and Events" are those processes and events which may occur in the geologic setting during the period following permanent closure of the repository which the program of investigations and analysis must consider, in addition to anticipated processes and events, to determine if they are required to be included in the analysis to determine

compliance with the overall system performance objectives of Section 60.112. "Unanticipated Processes and Events" include:

The primary function of "unanticipated processes and events" is--together with anticipated processes and events--to provide a group of processes and events which will provide the basis for determination of the site's ability to meet the overall system performance objective of Section 60.112. The Commission recognizes that not all processes and events need be considered in the final analysis, if the probability or consequences of the processes and events do not warrant consideration. See previous discussion on relationship to EPA Standard.

The phrase "not reasonably likely to occur during the period the intended performance objective must be achieved, but which are nevertheless sufficiently credible to warrant consideration" has been deleted from the definition. The definition now more specifically states the processes and types of events which must be investigated and evaluated by DOE.

By specifically stipulating that unanticipated processes and events, in addition to anticipated processes and events, must be investigated and evaluated to determine if they are required to be considered in determining compliance with the overall performance objective of Section 60.112, the basic function of unanticipated processes and events is clarified.

(a) Natural processes which reflect the maximum rate of the process during any distinct period during the Quaternary Period.

The Commission recognizes the cyclic and episodic nature of many natural processes and events and considers that the maximum rate during any extended time period during the Quaternary should be included in the evaluation.

(b) The recurrence of a natural event, which had occurred within the Geologic Setting during the Quaternary, at any location within the Geologic Setting at which it is credible for it to occur.

The Commission recognizes that there may be features or structures within the Geologic Setting which have no conclusive evidence of Quaternary activity but which, nevertheless, are similar to features or structures which were active during the Quaternary, or are features which are capable of future activity. The Commission considers that the potential for events to occur along such features should be considered in the analysis. The Commission further recognizes that the distinction between those events which should be considered in the anticipated processes and events and those events which should be considered in the unanticipated processes and events could become quite indistinct, based on our general knowledge, or lack of knowledge, of the controlling process. The decision as to which category of processes and events they should be placed in will be determined on a case-by-case basis.

(c) A natural process or event which has not occurred within the Geologic Setting during the Quaternary, but that has a cycle which could credibly result in an occurrence sometime during the intended period of performance.

The Commission recognizes that there may be processes and events which have a cycle of occurrence (or recurrence intervals) longer than the Quaternary Period, but which nevertheless have a probability of occurrence great enough to be included in determining compliance with the overall system performance objective in Section 60.112.

(d) A natural process or event which, due to the characteristics of the Geologic Setting, could occur even though there is no conclusive geologic evidence that it ever occurred within the Geologic Setting.

The Commission recognizes that the evidence from analogs, laboratory data, modeling and sensitivity exercises may indicate the need to consider a process or event, even though the geologic evidence within the geologic setting itself provides no indication that this process or event has ever occurred within the geologic setting. Such processes and events should be considered in determining which processes and events must be included in the analysis to determine compliance with the overall system performance objective.

(e) Human activities either within the controlled area or on other lands controlled by DOE under this Part, including direct human intrusion into the repository, and human-induced processes and events outside the controlled area or on land not controlled by DOE under this Part, provided it is assumed that: (1) the monuments provided for by this Part are sufficiently permanent to serve their intended purpose; (2) the value to future generations of potential resources within the site can be assessed adequately under the applicable provisions of this Part; (3) an understanding of the nature of radioactivity, and an appreciation of its hazards, have been retained in some functioning institutions; (4) institutions are able to assess risk and take remedial action at a level of social organization and technological competence equivalent to, or superior to, that which applied in initiating the processes or events concerned; and (5) relevant records are preserved, and remain accessible, for several hundred years after permanent closure.

There is no significant change in this section of the definition.

"Unanticipated Processes and Events" must take into account the perturbations caused by the presence of emplaced radioactive waste.

See the discussion of this subject under post-closure design basis processes and events.

3.3 Section 60.2--Definition of "Geologic Setting"

"Geologic setting" means the natural systems of the region in which a geologic repository operations area is or may be located.

See previous discussion on geologic setting.

3.4 Section 60.113(c)

The "Anticipated Processes and Events" used in the design and analysis of the waste package and the engineered barrier system(s) may be supplemented by additional processes and events if the Commission determines them necessary to provide reasonable assurance that the overall system performance objectives presented in §60.112 will be met. The processes and events which can be used to supplement the "Anticipated Processes and Events" are those "Unanticipated Processes and Events" which are required to be included in determining compliance with the overall system performance objectives of §60.112. In the specific case of the site at Yucca Mountain, these shall include, at a minimum, such things as the effects from nuclear weapons testing, the effects of groundwater pumpage, and changes to the climate caused by human-induced modifications to the atmosphere.

The revision of this section more specifically states what additional requirements the Commission has and can impose on DOE. The processes and events which can supplement the anticipated processes and events are not all unanticipated processes and events, but also those which have a probability and consequence great enough that they must be considered in determining compliance with the overall system performance objectives of Section 60.112. This change also more clearly reflects the interrelationship between the design of the engineered barrier system and the function of the geologic setting in providing full assurance that the multiple barrier concept is valid.

3.5 Subsection 60.113(b)

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 is satisfied.

This change is also made to more clearly reflect the interrelationship of the engineered barrier and natural portions of the entire waste isolation system. To assist in providing reasonable assurance that the site will adequately protect the public health and safety, changes to the performance objectives for the engineered barrier system can only be approved if, with such changes, the overall system performance objective is still met.

3.6 Section 60.102

(c) Areas related to isolation ***

The Geologic Setting comprises the natural systems of the region in which the geologic repository operations area is or may be located. The systems so identified typically have regularly interacting or interdependent components that form unified systems within the region. Accordingly, the Geologic Setting for a particular system is described by the geographic extent of that system; the geographic extent of the different systems need not be congruent.

See the previous discussion of geologic setting.

4. LINE-IN AND LINE-OUT FOR PROPOSED RULE MODIFICATION

4.1 Section 60.2

"Anticipated Processes and Events" ~~means those natural processes and events that are reasonably likely to occur during the period the intended performance objective must be achieved. To the extent reasonable in light of the geologic record, it shall be assumed that those processes operating in the geologic setting during the Quaternary Period continue to operate~~

are natural processes and events which may occur in the geologic setting, during the period following permanent closure, which have the following characteristics:

(a) "Anticipated Processes" are described by a conservative projection of the nature and the average rate of the process under consideration based on an analysis of the nature and rate of the process during the Quaternary Period and consideration of the spatial and temporal variability of the process.

(b) "Anticipated Events" are events similar in characteristics to events which occurred during the Quaternary Period. Such events should be assumed to occur at locations controlled by, or which evolved from, processes and mechanisms which controlled the Quaternary event. The characteristics of an anticipated event may be modified if analysis of the processes which are manifested by the event warrants such modification.

~~but with the perturbations of emplaced radioactive waste superimposed thereon.~~

"Anticipated Processes and Events" must take into account the perturbations caused by the presence of emplaced radioactive waste.

4.2 Section 60.2

"Unanticipated Processes and Events" ~~means those processes and events affecting the geologic setting that are judged not reasonably likely to occur during the period the intended performance objective must be achieved, but which are nevertheless sufficiently credible to warrant consideration. Unanticipated processes and events may be either natural processes and events or processes and events initiated by human activities other than those activities licensed under this part.~~

are those processes and events which may occur in the geologic setting during the period following permanent closure of the repository which the program of investigations and analysis must consider, in addition to anticipated processes and events, to determine if they are required to be included in the analysis to determine compliance with the overall system performance objectives of §60.112. "Unanticipated Processes and Events" include:

(a) Natural processes which reflect the maximum rate of the process during any distinct period during the Quaternary Period.

(b) The recurrence of a natural event, which has occurred within the Geologic Setting during the Quaternary, at any location within the Geologic Setting at which it is credible for it to occur.

(c) A natural process or event which has not occurred within the Geologic Setting during the Quaternary, but which has a cycle which could credibly result in an occurrence sometime during the intended period of performance.

(d) A natural process or event which, due to the characteristics of the Geologic Setting, could occur even though there is no conclusive geologic evidence that it ever occurred within the Geologic Setting.

~~Processes and events initiated by human activities may be found to be sufficiently credible to warrant consideration if it is assumed that:~~

(e) Human activities either within the controlled area or on other lands controlled by DOE under this Part, including direct human intrusion into the repository, and human-induced processes and events outside the controlled area or on land not controlled by DOE under this Part, provided it is assumed that: (1) the monuments provided for by this part are sufficiently permanent to serve their intended purpose; (2) the value to future generations of potential resources within the site can be assessed adequately under the applicable provisions of this part; (3) an understanding of the nature of radioactivity, and an appreciation of its hazards, have been retained in some functioning institutions; (4) institutions are able to assess risk and take remedial action at a level of social organization and technological competence equivalent to, or superior to, that which was applied in initiating the processes or events concerned; and (5) relevant records are preserved, and remain accessible, for several hundred years after permanent closure.

"Unanticipated Processes and Events" must take into account the perturbations caused by the presence of emplaced radioactive waste.

4.3 Section 60.2

"Geologic setting" means the natural ~~geologic, hydrologic, and geochemical~~ systems of the region in which a geologic repository operations area is or may be located.

4.4 Subsection 60.113(c)

~~Additional requirements may be found to be necessary to satisfy the overall system performance objective as it relates to unanticipated processes and events.~~

The "Anticipated Processes and Events" used in the design and analysis of the waste package and the engineered barrier system(s) may be supplemented by additional processes and events if the Commission determines them necessary to provide reasonable assurance that the overall system performance objectives presented in §60.112 will be met. The processes and events which can be used to supplement the "Anticipated Processes and Events" are those "Unanticipated Processes and Events" which are required to be included in determining compliance with the overall system performance objectives of §60.112. In the specific case of the site at Yucca Mountain, these shall include, at a minimum, such things as the effects from nuclear weapons testing, the effects of groundwater pumpage, and changes to the climate caused by human-induced modifications to the atmosphere.

4.5 Subsection 60.113(b)

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.

4.6 Section 60.102

(c) Areas related to isolation ***

~~There is an area, designated the Geologic Setting, which includes~~ The Geologic Setting comprises the natural ~~geologic, hydrologic, and geochemical~~ systems of the region in which the geologic repository operations area is or may be located. The systems so identified typically have regularly interacting or interdependent components that form unified systems within the region. Accordingly, the Geologic Setting for a particular system is described by the geographic extent of that system; the geographic extent of the different systems need not be congruent.

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