



Department of Energy  
Washington, DC 20585

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Division of High-Level  
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Office of Nuclear Material  
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U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Dear Mr. Linehan:

By letter dated August 30, 1989, the Nuclear Regulatory Commission (NRC) requested that the Department of Energy (Department) comments be submitted by September 21, 1989, concerning the NRC's draft technical position on Tectonic Models in the Assessment of Performance of High-Level Radioactive Waste Repositories, published for comment on June 19, 1989, (54 FR 25762).

In our letter to you dated August 8, 1989, we stated that the Department is in the process of preparing its final comments on this subject to be provided to you by September 29, 1989. Considering the importance of the tectonic models topic and the nature of our concerns, we believe that it would be more appropriate to defer finalizing this technical position pending the outcome of our planned discussions scheduled for September 26, 1989. However, we are providing you via this letter with our draft comments. The Department looks forward to meeting with your staff to discuss the concerns expressed in the enclosed draft comments.

These concerns include:

- The draft technical position adopts a position from a previous draft Generic Technical Position that anticipated and unanticipated processes and events should be identified based on deterministic, rather than probabilistic evaluations.
- The guidance provided in the draft technical position on the role of tectonic models in the performance allocation process appears to be inconsistent with previous DOE-NRC agreements.
- The draft technical position suggests that favorably oriented faults should be viewed as anticipated events even though they may not display Quaternary offset. This is inconsistent with past Commission statements.
- Tectonic models are equated with "predictive models" even though tectonic models tend to be conceptual in nature as opposed to quantitative.

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- It appears that positions regarding the needed level of conservatism are being formulated prior to collection of site data. This may result in positions that are not representative of regulatory requirements.

Please feel free to contact Mr. Steven H. Rossi of my staff on 586-9433 with any questions regarding this correspondence.

Sincerely,



Gordon Appel, Chief  
Licensing Branch  
Office of Civilian Radioactive  
Waste Management

Enclosure: Draft Comments On NRC Draft Technical Position On  
Tectonic Models In The Assessment Of Performance Of  
High-Level Radioactive Waste Repositories

cc: R. Loux, State of Nevada  
M. Baughman, Lincoln County, NV  
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**DRAFT COMMENTS ON NRC DRAFT TECHNICAL POSITION ON TECTONIC MODELS  
IN THE ASSESSMENT OF PERFORMANCE OF HIGH-LEVEL RADIOACTIVE  
WASTE REPOSITORIES**

**MAJOR COMMENTS**

1. While there may be a need to develop a common understanding regarding the development and completeness of tectonic models, the achievement of this goal by the draft technical positions is questionable, and in fact raises a number of questions regarding the overall theme behind the NRC's use of technical positions. For example, Section 1.4 states that "technical positions are issued to describe and make available to the public criteria and methods acceptable...for implementing specific parts of the Commission's regulations." Thus, it is reasonable to assume that explicit criteria for developing acceptable tectonic models would be provided. However, it is our opinion that the technical position provides only a general discussion. The technical position also discusses a number of items that have little to do with tectonic models. For example, the role and use of probabilistic techniques is discussed along with the use of models in completing performance allocation. Both topics are generic issues that have little to do with how one develops tectonic models. Additionally, the use of terms such as "demonstrate" and "bounding" are related more to judgments of needed conservatism than to how tectonic models should be developed. Such judgments are premature considering that site characterization has not been initiated and may result in positions that are unachievable.
  
2. The technical position reiterates the position taken in the NRC draft generic technical position on Guidance for Determination of Anticipated Processes and Events and Unanticipated Processes and Events (February 1988) that processes and events should be identified as anticipated or unanticipated based on deterministic evaluations. As previously stated in the DOE comments on that draft generic technical position (R. Stein, DOE, to R. Ballard, NRC, letter dated August 15, 1988), the DOE believes that determination of anticipated and unanticipated processes and events is dependent on the probability of occurrence of the process or event during a particular period of performance. The NRC position that the probability of future occurrence should not be considered is inconsistent with the probabilistic EPA standard in 40 CFR Part 191 and contrary to the 10 CFR Part 60 definitions of anticipated and unanticipated processes and events.

The EPA recognized that there would be substantial uncertainties in predicting the performance of a geologic

repository and made the containment standard probabilistic to account for these uncertainties. The primary function of the NRC numerical performance objectives for components of the engineered barrier system [10 CFR 60.113(a)(1)] and for pre-waste-emplacement ground-water travel time [10 CFR 60.113(a)(2)] is to reduce the uncertainties in meeting the EPA standard. Thus, the NRC subsystem performance objectives are subsidiary to the EPA standard. However, the rejection of probabilistic considerations in identifying anticipated and unanticipated processes and events suggests a need for a greater degree of certainty for demonstrating compliance with the NRC performance objectives than that required for demonstrating compliance with the EPA standard.

In addition, by 10 CFR Part 60 definition, the terms anticipated and unanticipated imply a probabilistic approach since they are defined in terms of likelihood of occurrence during a particular period the intended performance objective must be achieved. The period of performance ranges from 10,000 years for the EPA standard to possibly as short as 300 years for waste package containment. Proper consideration of the variability of the intended period of performance can only be accomplished through probabilistic methods.

In arguing against the use of probabilities, Section 4.3 of the technical position quotes from the supplementary information to the June 21, 1983, 10 CFR Part 60 final rulemaking on technical criteria for the disposal of high-level radioactive waste in geologic repositories (48 FR 28194). It states:

"Identification of anticipated and unanticipated processes and events for a particular site will require considerable judgment and will not be amenable to accurate quantification, by statistical analyses, of their probability of occurrence."

In our opinion, the Commission's caution is well placed. However, it does not foreclose the use of probabilistic considerations. The choice of techniques for identifying anticipated and unanticipated processes and events should not be arbitrarily limited and should take into consideration both probabilistic and deterministic techniques.

3. Section 2.2 states that for the purposes of this technical position "...tectonic models are considered to be predictive models, because they can be used to predict future conditions and changes in the geologic setting in response to tectonic processes." The term predictive model is not clearly defined in the technical position and could be misinterpreted.

The role of tectonic models is to provide a mechanism for describing the set of viable hypotheses regarding the tectonic setting, internal geometry, and governing processes that are consistent with each other and that are compatible with available data, recognizing uncertainties that are likely to exist. As such, tectonic models tend to be conceptual in nature, as opposed to quantitative. While tectonic models can assist in developing numerical models, a direct linkage (equating a tectonic model with a predictive model) may not be possible given the scientific complexity of trying to explain tectonic processes that are operative at any site. Tectonic models need not be equated with predictive models, and there should not be an expectation that the tectonic models developed for a repository site can or should be numerical in nature. Such an expectation is likely nonachievable and could result in a misguided site characterization program.

Past NRC experience with developing tectonic models for the eastern United States, including issues such as the explanation of the 1886 Charleston, South Carolina earthquake, support the contention that one should not expect a full understanding of tectonic processes given even years of intense study.

4. The technical position addresses the role tectonic models should play in developing plans for site characterization and in the performance allocation process that underlies the Site Characterization Plan (SCP). The indication in the technical position is that the studies identified in the SCP are inadequate because they are not based on a complete range of tectonic models. This appears to be new guidance on how the performance allocation process should be implemented.

On April 17, 1985, and September 26-27, 1985, the DOE and NRC met to discuss performance allocation and the problem of developing site characterization plans in the face of incomplete site information. During these meetings, it was concluded that in many cases it would not be possible to base test plans on predictive models before obtaining site data and that expert judgments would have to be used to form the basis for such plans. The issue resolution strategies and performance allocations specified in the SCP are consistent with the agreements reached during those meetings. In addition, on April 11-14, 1988, the DOE and NRC held a meeting to discuss how alternative conceptual models should be addressed in the SCP. There has been no indication from the NRC that the performance allocation process described in the SCP is inconsistent with those agreements. Therefore, considering the status of the SCP, it is inappropriate for the technical position to be suggesting a change in the performance allocation process.

5. The meaning of the term "full range", which is used throughout the technical position, is not clear. For example, Section 2.2.2 states that "...it should be demonstrated that the full range of alternative tectonic models, supported by available evidence and inclusive of anticipated and unanticipated processes and events, has been identified." Section 3E states that "DOE should demonstrate that the program of site characterization...will provide data that are sufficiently representative of the events and processes in the geologic setting that the full range of conditions at the site can be identified...."

At the present, the SCP identifies a range of alternative hypotheses to be investigated during site characterization. It is impractical to suggest that the full range of models or conditions at the site can be identified, particularly at this point in time. The alternative hypotheses identified in the SCP will be tested iteratively during site characterization. The activities identified in the SCP will be initiated and new studies/activities will be added, as necessary, for resolution among models.

6. Section 2.2.1 suggests that the radiological protection criterion of 10 CFR 60.111(a) is a performance objective for "bounding conditions of possible tectonic events in the repository operations area...." 10 CFR 60.111(a) states that "...until permanent closure...radiation exposures and radiation levels, and releases of radioactive materials to unrestricted areas, will at all times be maintained within the limits specified in Part 20."

As indicated in previous DOE comments on the NRC draft generic technical position on Items and Activities in the High-Level Geologic Repository Program Subject to 10 CFR 60 Quality Assurance Requirements (J. Knight, DOE, to J. Linehan, NRC, letter dated March 3, 1987), the DOE believes the phrase "at all times" in 10 CFR 60.111(a) was not intended to extend the dose limits of 10 CFR 20 to accident situations. Rather it was intended to emphasize the need to design the repository operations area so that any future waste retrieval could be performed in accordance with the radiation protection requirements for normal operations.

The appropriate regulatory reference for tectonic design bases during the preclosure period is 10 CFR 60.131(b). This design criterion requires structures, systems, and components important to safety to be designed so that natural phenomena, such as tectonic events, and environmental conditions anticipated at the geologic repository operations area will not interfere with necessary safety functions.

7. Section 4.1 states that the "...faults at the site that are favorably oriented for failure in the present stress regime should be viewed both in the context of faults with demonstrated Quaternary movement and in the context of a realistic conceptual tectonic model(s)." The technical position then strongly suggests that displacement along these favorably oriented faults should be viewed as an anticipated event "...even though they [the faults] may not display Quaternary offset."

The term "stress regime" needs to be clearly defined. Unless we know the meaning of the term "stress regime" we cannot identify "favorably oriented faults." Moreover, we do not understand what magnitude and rate of offset should be assumed for the anticipated event if these faults do not display Quaternary offset.

Also, we do not understand the reasoning for consideration of faults "...even though they [the faults] may not display Quaternary offset." This position is inconsistent with 10 CFR Part 60 which clearly defines anticipated processes and events as those that are reasonably likely to occur "...in the light of the geologic record...and...operating in the geologic setting during the Quaternary Period..." (10 CFR 60.2). The draft technical position would expand this definition to include processes that are "likely to have been active" but are "not evidenced in the Quaternary Record."

Unless there is reason to believe that crustal stresses during the next 10,000 years will be atypical of the Quaternary stress regime, the absence of Quaternary movement on a fault is prima facie evidence that future fault movement is not reasonably likely and, therefore, not anticipated. Stated another way, if one constructs a model of the local stress field, fault geometry, and characteristics that predicts that fault movement is reasonably likely to occur in a 10,000 year period, but the geologic record indicates that in fact the fault has not moved in the last 2 million years, then the model has been invalidated, i.e., something is wrong with, or missing, from the model.

The position that faults that have not slipped during the Quaternary Period are not reasonably likely to slip in the next 10,000 years is supported by the NRC as evidenced by the supplementary information to the July 8, 1981, 10 CFR Part 60 proposed rule on disposal of high-level radioactive waste in geologic repositories (46 FR 35281). The NRC states in the supplementary information that "an example of an unlikely event would be the reactivation of a fault within the geologic setting which had not exhibited movement since the start of the Quaternary Period."

## ADDITIONAL COMMENTS

### 8. Page 2, Section 2.2

The statement "as defined in 10 CFR 60.21(c)(1)(ii)(F), 'predictive models' are...." is misleading. 10 CFR 60(c)(1)(ii)(F) does not explicitly define "predictive models." We suggest deleting the phrase "as defined by 10 CFR 60.21(c)(1)(ii)(F)" from the sentence.

### 9. Page 3, Section 2.2.1

Section 2.2.1 states that "the bounding conditions of possible tectonic events in the repository operations area should be established to develop design bases" and that "the use of thoroughly supported tectonic models is a mechanism for bounding the tectonic events that are reasonably likely to occur in the preclosure period."

It is not clear what is meant by the term bounding conditions and such a statement appears to prejudge the level of conservatism needed with respect to developing design bases. Judgments regarding the design bases will need to consider the range of potential tectonic events, but this does not mean that tectonic models should be explicitly used to set the design. The level of conservatism for design is dependent on many factors, including considerations such as design margins (factors of safety) and consequences of failed engineered items. To require design bases to bound the possible conditions from tectonic models is likely to be nonrepresentative of actual facility radiological risk and may not result in a safer preclosure facility.

### 10. Page 4, Section 2.2.2

This Section states that "...it should be demonstrated that the full range of alternative tectonic models...has been identified" and that "DOE should demonstrate that the methods used to derive projections of future tectonic processes and events...are sufficient to assure that the design of the engineered barriers system will meet the performance objective." In both instances the use of the term "demonstrate" is not clear. How this term is defined is important in determining if expectations regarding the use of tectonic models are appropriate or not.

11. Page 5, Section 2.2.3; also Page 6, Section 3(D); and Page 8, Section 4.3

These sections reference the NRC draft generic technical position on Guidance for Determination of Anticipated, Processes and Events and Unanticipated Processes and Events. It is inappropriate for a technical position to reference a draft generic technical position, especially one in which DOE and NRC differences have not been resolved. See comments 2 and 3.

12. Page 5, Section 2.2.4

The technical position states that "to develop a list of mutually exclusive scenarios involving tectonics that is sufficiently complete to demonstrate compliance with 10 CFR 60.112, a comprehensive model or set of models of tectonic activity must be available on which to base the selection."

Tectonic scenarios are not mutually exclusive. Many tectonic scenarios share a common origin. For example, the same controlling structure may cause an earthquake in one instance but volcanism in another. We suggest deleting the term "mutually exclusive" from the sentence.

13. Page 6, Section 3B

This section states that "the iterative process of model creation, modification, abandonment, and model confirmation should begin during site characterization and continue until permanent closure (10 CFR 60.140 and 10 CFR 60.141)." 10 CFR 60.140 and 141 do not explicitly state such and, thus, should not be referenced.

14. Page 6, Section 3C

It is not clear how alternative tectonic models are expected to "...form one of the principal bases for input into the identification of anticipated processes and events and, therefore, in the design of the engineered barrier system...."

The definition of anticipated processes and events (10 CFR 60.2) states that "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." With a probabilistic definition of "reasonably likely" it is relatively straightforward to judge whether processes and events predicted by a tectonic model are anticipated. The probability of an event being the product of the probability of the event occurring under the

model and the probability that the model is applicable. However, without a probabilistic interpretation of reasonably likely, it is not clear how to factor alternative models into the determination of anticipated events.

15. Page 6, Section 3D

Age determination alone is insufficient to establish volcanism as an anticipated or unanticipated process. Additional information concerning volume-frequency relations, variation of compositional parameters as clues to the evaluation of the underlying magmatic reservoir, and possible links between stress regime and eruptions are required for a deterministic volcanic model.

16. Page 6, Section 4.1

This Section provides comment on the SCP regarding consideration of alternative conceptual models. The Department believes that as technical position is not the appropriate vehicle for the NRC to be commenting on the SCP. Such comments belong in the NRC Site Characterization Analysis. We suggest deleting the comment on the SCP from the technical position.