

DEC 15 1988

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1

MEMORANDUM FOR: Robert E. Browning, Director  
Division of High-Level Waste Management  
Office of Nuclear Material Safety  
and Safeguards

FROM: Ronald L. Ballard, Chief  
Geosciences & Systems Performance Branch  
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Office of Nuclear Material Safety  
and Safeguards

SUBJECT: SCOPE OF TECHNICAL POSITION ON TECTONIC MODELS

Enclosed is a scope developed by the Geosciences and Systems Performance Branch (HLGP) of a Technical Position (TP) dealing with the use of Alternative Conceptual Tectonic Models in performance allocation and performance assessment of a geologic repository. This TP was prepared using the Division's work plan on the development of TPs. The scheduled completion date is estimated to be October 30, 1989, and the resource impact to the Division will be approximately 0.4 FTE.

In accordance with the HLWM work plan, those parties receiving copies of this memorandum who are listed below are encouraged to provide recommendations on the need to continue development of this TP. All recommendations should be provided to the Director within ten work days of the date of this memorandum. If you require any additional assistance, please contact the HLGP staff member responsible for development of this TP, Keith McConnell at extension 20532.

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Enclosures:  
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88/12/

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Approved, R. E. Browning

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2

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SCOPING DOCUMENT FOR THE  
TECHNICAL POSITION ON TECTONIC MODELS  
FOR ASSESSMENT OF PERFORMANCE OF HIGH-LEVEL  
RADIOACTIVE WASTE REPOSITORIES

1. REGULATORY EVALUATION

1.1 Requirements:

Under 10CFR60, the DOE is obligated to use models for determining the long term performance of a repository. This obligation and requirements for the development and confirmation of models are specified in 10 CFR 60.101(a)(2) and 60.21(c)(1)(i)(F) which state that:

Demonstration of compliance with long-term performance objectives and criteria will "involve the use of data from accelerated tests and predictive models that are supported by such measures as field and laboratory tests, monitoring data and natural analog studies" [60.101(a)(2); emphasis added]; and

the DOE should provide "an explanation of measures used to support models used to perform the assessments required..." and "Analyses and models used to predict future conditions and changes in the geologic setting shall be supported using an appropriate combination of such methods as field tests, in situ tests, laboratory tests which are representative of field conditions, monitoring data, and natural analog studies..." [60.21(c)(1)(i)(F); emphasis added].

1.2 Implementation of Requirements Under 10CFR60::

As defined in 60.21(c)(1)(i)(F), "predictive models" are models used to predict future conditions and changes in the geologic setting. Applying this definition of predictive model to the scientific investigations outlined in the Consultation Draft Site Characterization Plan (CDSCP) has resulted in the use of a synonymous, but more descriptive term "alternative conceptual model(s)" (NRC Objection #1, CDSCP). As a result, this technical position treats the terms predictive model and alternative conceptual model as synonyms but uses alternative conceptual model to be consistent with the NRC staff's comments on the CDSCP.

The requirement in 10CFR60.101 for the use of alternative conceptual models in general and alternative conceptual tectonic models (ACTM) in particular was developed to address gaps in the geologic record in the area of the site. Gaps in the geologic record result in a database that is insufficient to establish the full range of geologic conditions and parameters at the site, a requirement in 60.2. Total reliance on the empirical database is, therefore, likely to result in an inability to predict the potential for the presence of "undetected" features at the site and an inability to completely bound the

possible future behavior of natural systems. For example, estimates of the likelihood of a geologic event that could disrupt the repository can only be made on the basis of the geologic record for a particular site. Gaps in the geologic record may lead to unacceptably high levels of uncertainty about the likelihood of this event and in any event will involve considerable uncertainty. In circumstances like those described above, reliance on models based on the available data is required to attempt to bound the likelihood of the possible disruptive geologic event.

**1.2.1 Preclosure Period:** In the preclosure period, the requirements for releases of radioactive material [60.111 (a)] and the retrievability of waste [60.111 (b)] require that the design of repository operations area must be such that: 1) "...so 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..." and 2) "...so that any or all of the emplaced waste could be retrieved on a reasonable schedule starting at any time up to 50 years after waste emplacement operations are initiated..." To assure that the design of the repository operations area will meet the performance requirements, the bounding conditions of possible tectonic events in the repository operations area should be established to develop design bases. Thoroughly documented and tested alternative conceptual tectonic models are a mechanism for bounding the tectonic events that are reasonably likely to occur in the preclosure period.

**1.2.2 Postclosure Period:** During the postclosure period, the objectives of the long term performance of a potential repository are outlined in 10 CFR 60.112 (specifies the performance requirements for the overall system) and 60.113 (specifies the performance requirements of particular barriers after permanent closure). More generally, 10CFR60.2 outlines the requirements for establishing geologic conditions at the site and 60.122 outlines the procedures for investigating favorable and potentially adverse conditions at the site during site characterization.

Under 60.112,

"The geologic setting shall be selected and the engineered barrier system and the shafts, boreholes and their seals shall be designed to assure that releases... conform to such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency with respect to both anticipated processes and events and unanticipated processes and events."

As will be described, conceptual tectonic models have a key role in determining the processes and events that are reasonably likely to occur in the period of concern for the repository and, therefore, in defining anticipated and unanticipated processes and events. In order for the DOE to provide reasonable assurance that the long-term performance of the repository will meet the requirements under 60.112, the DOE should demonstrate that the full range of alternative conceptual tectonic models supported by available evidence have

been identified and evaluated for potential adverse effects on the overall system performance.

Under 60.113,

"The engineered barrier system shall be designed so that assuming anticipated processes and events: (A) Containment of HLW will be substantially complete during the period when radiation and thermal conditions in the engineered barrier system are dominated by fission product decay; and (B) any release of radionuclides from the engineered barrier system shall be a gradual process which results in small fractional releases to the geologic setting over long times."

Similar to the overall system performance requirement, 60.113(a)(1) requires that the engineered barrier system be designed assuming anticipated processes and events which, in large part, will be defined using conceptual tectonic models. However, 60.113(a)(1) also requires that releases from the engineered barrier system be gradual over long times. This requirement, strictly interpreted, places narrow constraints on the allowable uncertainty in the conceptual tectonic model(s) used in the design of the engineered barrier system. For example, rupturing of canister(s) by fault movement could result in an abrupt release of radionuclides from the engineered barrier over a relatively short period of time, thus violating 60.113. The DOE should provide reasonable assurance that the tectonic model used to derive projections of future tectonic events is sufficiently constrained to assure that the design of the engineered barrier system will meet the performance objective.

10CFR60.2 requires that the program of exploration and research undertaken during site characterization should establish the geologic conditions and the ranges of those parameters at a particular site. More specifically, 10 CFR 60.21(1)(ii)(B) states that the DOE is required to provide:

"Analyses to determine the degree to which each of the favorable and potentially adverse conditions, if present, has been characterized, and the extent to which it contributes to or detracts from isolation."

The procedure for fulfilling the requirement in 60.2 is outlined in 10CFR60.122(a)(1) which states that the DOE should demonstrate that:

"The potentially adverse...natural condition[s] has been adequately investigated, including the extent to which the condition may be present and still be undetected taking into account the degree of resolution achieved by the investigations" and that "The effect of the potentially adverse ... natural condition on the site has been evaluated using analyses which are sensitive to the potentially adverse ...natural condition and assumptions which are not likely to underestimate its effect."

Tectonics and conceptual tectonic models describe the geometric and mechanical relationship between observed structural features and past and/or present tectonic processes. In addition to explaining observed structural features, a tectonic model may also lead to the prediction of structural features which lack geomorphic expression. The potential for future tectonic events has a direct impact on performance allocation and on the design and location of surface facilities as well as the design of the engineered barrier system. Tectonic models, therefore, provide investigators a basis from which to evaluate future tectonic events and potentially disruptive scenarios.

1.2.3 Anticipated and Unanticipated Processes and Events: Tectonic models have a key role in determining the processes and events that are reasonably likely to occur in the period of concern for the repository (i.e., anticipated processes and events). The determination that a tectonic process is an anticipated process requires the development of a "reasonable and conservative projection of the rate of the process that is occurring or that has occurred, within the geologic setting during the Quaternary Period" (Draft Rulemaking on APE and UPE). An incomplete geologic record in the area of the repository necessitates that, with respect to tectonics, a model based on empirical geologic data derived during site characterization be used to determine which processes are reasonably likely to be active during the Quaternary.

1.2.4 Tectonic Models as a Basis for Scenario Selection: As a result of their role in defining which processes and events are anticipated and unanticipated processes and events, tectonic models will play a key role in the development of scenarios. The EPA containment requirements of 40CFR191.13 requires that the sum of the cumulative releases be assessed from all significant process and events (draft TP, Scenarios). In order to develop a complete list of mutually exclusive scenarios for tectonics at the Yucca Mountain site, a comprehensive model of the tectonic activity should be available on which to base the selection. The NRC staff emphasized this concern for the use of conceptual models in the development of scenarios in the DOE-NRC Conceptual Models meeting (April, 1988). In that meeting, the NRC staff stated that conceptual models:

"...if confirmed, be used to calculate releases for all scenarios needed to show compliance with the EPA standard" (NRC comments, DOE-NRC Conceptual Models Meeting, April, 1988).

## 2. GUIDANCE TO BE PROVIDED BY THIS ANALYSIS

The objective of this technical position is to outline the regulatory requirements for consideration of alternative conceptual tectonic models and prescribe the types of information required and the steps in the process of using alternative conceptual tectonic models that should be included in the Site Characterization Report and License Application. Adherence to this Technical Position will ensure the correct use of conceptual models and the completeness of the information provided and will aid in shortening the time required for review.

The guidance presented in this technical position on conceptual tectonic models will provide the DOE with a regulatory perspective for the use of alternative conceptual tectonic models (ACTM) during site characterization and the licensing process. This guidance will specifically describe the NRC staff's position on the use of alternative conceptual tectonic models in the performance allocation and performance assessment processes.

Alternative conceptual models will also be used in assessing other aspects of repository performance (e.g., releases to the accessible environment). The approach provided in this position for the use of alternative conceptual tectonic models can be considered as generic for other areas that require alternative conceptual models (e.g., groundwater flow).

Specific points to be addressed in the technical position include:

- 1) a regulatory analysis of the requirement and the implementation of the requirement for the use of "predictive models" in general and ACTM in particular under 10CFR60;
- 2) the NRC staff's position on the use of alternative conceptual tectonic models in the performance allocation and performance assessment processes;
- 3) a list of information needs necessary to demonstrate compliance with 10CFR60.101(a)(2) and 10CFR60.21(c)(1)(i)(F).

### 3. JUSTIFICATION FOR TECHNICAL POSITION ON TECTONIC MODELS

The justification for this technical position is derived from three of the criteria for technical positions outlined in section 2.0 of Waste Management Policy #46. Specifically, the justification for this technical position is based on criteria 2, 3, and 4 which are listed below.

- 2) areas where it has become apparent to the staff that the DOE does not view the regulations in the same way the staff does;
- 3) parts of the regulations or subject matter that are particularly complex or controversial;
- 4) areas that could be potentially troublesome during the hearing process.

The technical position on tectonic models is an attempt to clarify the regulatory uncertainty on their use in site characterization and licensing and is the direct result of concerns originally raised in the staff's review of the Consultative Draft Site Characterization Plan.

The requirement under Part 60 for the use of conceptual (i.e., predictive) models during characterization of the proposed repository at Yucca Mountain was emphasized to the DOE in the NRC staff's review of the NNWSI CDSCP. In that review the NRC staff noted that the full range of alternative conceptual models supported by available evidence from the Yucca Mountain area had not been systematically and clearly identified. The NRC staff concluded that alternative conceptual models should form the basis for preliminary performance allocation. In addition, the NRC staff concluded that conceptual models should:

- 1) form the basis for the predictive performance assessments of repository systems and subsystems, and

- 2) if confirmed, be used to calculate releases for all scenarios needed to show compliance with the EPA standard (NRC comments, DOE-NRC Conceptual Models Meeting, April, 1988).

In the April, 1988, meeting on Alternative Conceptual Models, the DOE agreed that they would provide in the statutory SCP a table listing the full range of conceptual models for all major disciplines. This was confirmed in a DOE presentation before the ACNW (June 28, 1988) in which the DOE presented their intentions to provide tabular listings of conceptual models for hydrology, tectonics and other major disciplines.

However, providing tables of alternative conceptual tectonic models does not, by itself, resolve the NRC staff's concern that alternative conceptual models form the basis for preliminary performance allocation and performance assessment. As presently defined in the CDSCP, tectonic models will:

"...ensure that assumptions that are made about the local manifestation of tectonic processes are consistent with current scientific understanding of tectonic processes..."

and,

"...document the scientific uncertainty in the characterization of tectonic hazards so that it can be accounted for in evaluations of repository design and performance."

The uses of tectonic models defined in the CDSCP and specified above are not consistent with the requirements for "predictive models" or alternative conceptual models in 10CFR60 and the NRC staff's position following its review of the CDSCP. Alternative conceptual tectonic models as presently outlined in the CDSCP will be used primarily as confirmatory tools during site characterization but will not be used in the performance allocation process or in predictive assessments of tectonic activity. This Technical Position will provide the DOE with a detailed description of the NRC staff's position on the use of alternative conceptual tectonic models to meet the requirements specified in 10CFR60.101(a)(2).



#### 4. REGULATORY DEVELOPMENT AND LICENSE REVIEW PROCESS

The Center for Nuclear Waste Regulatory Analysis (CNWRA) will fill a key role in the development of the position on the use of alternative conceptual tectonic models. The CNWRA will review the draft position and provide detailed comments on the information needs and elements of proof needed to fulfill the regulatory requirements for the use of predictive models.

The NRC staff's position on the use of alternative conceptual models has been presented to the DOE in the comments on the CDSCP. However, it is uncertain at this time if the DOE fully understands the requirements under 10CFR60 for the use of conceptual models. This technical position will attempt to clarify the regulatory uncertainty related to the use of alternative conceptual tectonic models during site characterization and, therefore, reduce the technical uncertainty related to performance issues and tectonics.

The analysis of the use of alternative conceptual tectonic models presented in this technical position exceeds the scope of a letter to the DOE. In addition, the purpose of this technical position is not to provide information on how to review a license application containing a tectonic model, but rather is a clarification and interpretation of the use of predictive models, in this case tectonic models, under 10CFR60. This technical position is, therefore, also outside the scope of a review guide or regulatory guide.

Major efforts are currently underway at the NRC to assess and validate computer codes used to model unsaturated flow (Intraval) and behavior of the waste package (Convocode). At the present time neither of these efforts is considering the effects on the system of anticipated processes and events and, therefore, they are only considering baseline or nominal conditions. A final analysis of unsaturated flow and waste package containment with respect to the ability of the repository to meet the performance objectives must be integrated with conceptual tectonic models which establish the full range of tectonic events that are reasonably likely to occur.

Prior to issuance of this technical position in the Federal Register, a meeting with the DOE, U.S. Geological Survey, and State of Nevada should be held on the topic of alternative tectonic models. This meeting would discuss those tectonic models currently under consideration by the U.S.G.S. and DOE and their use in performance allocation during site characterization. The format of the meeting would be similar to that of the Alternative Conceptual Models meeting held in April, 1988, except that a data review conducted at the outcrops and in the Sample Management Facility would be required. Reviewers would observe outcrops, core, and photographs, compare the data to that used to support conceptual tectonic models, and evaluate the results.

STANDARD MILESTONES AND SCHEDULES FOR THE  
DEVELOPMENT OF THE TECHNICAL POSITION ON  
ALTERNATIVE CONCEPTUAL TECTONIC MODELS

Milestone	Elapsed Time(wk)	Accumulated Time(wk)	Date
Initiate need for TP	0	0	08/23/88
Obtain Program, Planning, and Status Assessment System (PPSAS) number			10/24/88
Scope complete	8	8	12/15/88
Determination of need for TP (1)	2	10	12/30/88
Notify special parties of the staff intent to issue a TP			05/24/88
Preliminary meeting, if necessary			06/14/89
Internal Draft			07/05/89
Internal NRC Comments	4		08/12/89
Public-comment draft	8		10/10/89
<u>Federal Register</u> Notice/ transmittal to Advisory Committee on Nuclear Waste	3		11/01/89
Public comment period closed	8		12/26/89
Evaluation of Comments and Revision of TP	6		
Public meeting on disposition of comments	2		02/21/90
ACNW review	2		03/04/90
Complete Final TP	4		
Issue Final TP	4		10/30/89

(1) Approach taken by the TP is dependent upon treatment of predictive models in SCP. Therefore, scope will likely need to be modified based upon review of SCP. We are delaying subsequent milestones by 6 months.

TECHNICAL POSITION ON THE USE OF TECTONIC MODELS  
FOR ASSESSMENT OF PERFORMANCE OF HIGH-LEVEL  
RADIOACTIVE WASTE REPOSITORIES

1. INTRODUCTION

- 1.1. Purpose
- 1.2. Scope
- 1.3. Structure of Technical Position
- 1.4. Alternatives

2. REGULATORY BACKGROUND

- 2.1. Requirements
  - 2.1.1. 10CFR60.101(a)(2) and 10CFR60.21(c)(1)(ii)(F)
- 2.2. Implementation of Requirement Under 10CFR60
  - 2.2.1. Performance Allocation
  - 2.2.2. Performance Assessment
    - 2.2.1.1) Preclosure period
    - 2.2.1.2) Postclosure period
    - 2.2.1.3) Anticipated and unanticipated processes and events
    - 2.2.1.4) Selection of Scenarios

3. TECHNICAL POSITION

4. DISCUSSION

- 4.1. Rationale for position on alternative conceptual tectonic models
- 4.2. Information needs related to bounding natural conditions in tectonic models
  - 4.2.1. Discussion of Events and Processes
    - 4.2.1.1) Tectonic history
    - 4.2.1.2) Volcanic history
    - 4.2.1.3) Faulting history
    - 4.2.1.4) Folding history
    - 4.2.1.5) Jointing history
    - 4.2.1.6) Vertical crustal movements (i.e., uplift, tilting, rotation, and subsidence)
    - 4.2.1.7) Stress field history
    - 4.2.1.8) Seismicity of the area
  - 4.2.2. Description of processes with particular emphasis on the rate
    - 4.2.2.1) During the Quaternary Period
    - 4.2.2.2) Projections of future processes and

events

4.3. Model conformance with existing data

4.4. Representativeness of database

4.5. Integration of conceptual tectonic models with other  
conceptual models

4.6. Consideration of the use of Probabilities in  
the use of tectonic models

5. REFERENCES CITED

6. BIBLIOGRAPHY

7. GLOSSARY

7.1. Definitions of terms used in this Technical Position

7.1.1. Predictive model

7.1.2. Conceptual model

7.1.3. Geologic Setting

7.1.4. Tectonics

7.1.5. Tectonic setting

7.1.6. Conceptual tectonic model

7.1.7. Tectonic framework

7.1.8. Tectonic history

7.2 Acronyms