

JUL 24 1990

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

FROM: Joseph O. Bunting, Chief  
Engineering Branch  
Division of High-Level Waste Management

SUBJECT: PROPOSED TECHNICAL POSITION ON "APPLICATION OF  
SEISMIC AND FAULTING DESIGN BASES TO ENGINEERING  
DESIGN OF GEOLOGIC REPOSITORY OPERATIONS AREA  
SURFACE FACILITIES"

This memorandum is to inform you that the Engineering Branch tentatively intends to proceed with the development of technical position (TP) on "Application of Seismic and Faulting Design Bases to Engineering Design of Geologic Repository Operations Area Surface Facilities." The proposed scope and a draft annotated outline of the technical position are attached. This is a self-initiated effort and is not specifically budgeted.

As previously instructed by you, the division of high-level waste management staff is preparing an overall strategy to provide guidance to the Department of Energy (DOE) in the area of seismic and faulting investigations and the application of resulting information to the design of geologic repository operations area. As a part of this strategy, the Engineering Branch (HLEN) staff plans to develop two technical positions; one for surface facilities and the other one for underground facility. The subject TP will provide guidance to the DOE in applying the seismic and faulting design bases to surface facilities design. Later on, the HLEN staff plans to develop a separate TP on seismic and faulting considerations for design of underground facility.

It is possible that the development of the subject TP might take longer time than projected in Appendix B of the WM Policy # 46 because of the following reasons: (i) The HLEN staff intends to coordinate the positions in this TP with the on-going work by the Center for Nuclear Waste Regulatory Analyses (CNWRA) on the development of Repository Operations Criteria (ROC) and the need for this coordination might necessitate a delay in the finalization of the positions in the TP; and (ii) The subject of design methodology for seismic and faulting is very controversial in nature and resolution of issues may involve more time than is normally necessary. Because of the possibility that we may need more time to develop this TP, it is important that we start the development of this TP soon. If you do not agree, please notify me as soon as possible.

Through this memo, I also request the Project Directorate and the Geosciences and Systems Performance Branch to review the attached scope and draft annotated outline of the proposed technical position and provide me their comments by

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August 6, 1990. We will schedule a HLWM management meeting shortly thereafter to discuss the comments and reach a final decision on whether to proceed. If the decision is favorable, we will also need to identify technical interface and task group members needed for TP development, as required by WM policy # 46.

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Enclosure:  
As stated

cc:

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**SCOPE OF THE PROPOSED TECHNICAL POSITION ON APPLICATION OF SEISMIC AND FAULTING DESIGN BASES TO ENGINEERING DESIGN OF GEOLOGIC REPOSITORY OPERATIONS AREA SURFACE FACILITIES**

**1. NEED FOR GUIDANCE**

1. **Particularly Controversial Subject Matter:** The subject of seismic and faulting design is very controversial. It is particularly the case for design of facilities at the Yucca Mountain site which is currently under investigation for site suitability. There are many expert opinions on the subject and very often, the experts do not view the requirements for the seismic and faulting design methodology in the same way. The staff intends to clearly lay out its position and suggest a method acceptable to the NRC staff for DOE to meet regulatory requirements in designing the GROA surface facilities for seismic and faulting conditions.
2. **Potentially Troublesome Area during Hearing Process:** Guidance provided in 10 CFR 60.21(c)(3), 60.111 and 60.131(a) and (b)(1) on seismic and faulting design methodology is very generic and non-specific. This raises the possibility that the staff may not have defensible basis to support its findings on the adequacy of the GROA design in this area during the license hearing process. A technical position in this area, which would have undergone the public scrutiny, is more likely to provide a sound basis for reviewing the license application and for staff to use it as a basis for its findings.
3. **Previous Experience indicates Need for Guidance:** During licensing reviews of reactors, the area of seismic design has been particularly troublesome and controversial. NRR experience clearly indicates that there is vital need for timely guidance to DOE in this area to avoid potential future misunderstanding of staff positions and requirements.

Based on the above considerations, the need for guidance development in this area has been clearly established.

**2. TYPE OF GUIDANCE**

The guidance will cover the following topics:

- A. **DESIGN METHOD FOR SEISMIC LOADING -**
  - a. Seismic input form
  - b. Modeling for seismic system analysis
  - c. Seismic Analysis Methods
  - d. Modal damping
  - e. Modal Combinations
  - f. Load Combinations

## B. DESIGN BASIS FOR SURFACE FAULTING

- a. Surface Faulting Design Basis
- b. Direction and Azimuth of Faulting

Positions acceptable to NRC staff in each of these areas will be discussed in detail. An annotated outline of the proposed TP is being developed (see Attachment 1 for a preliminary draft of this outline). It will be presented to the task group members consisting of designated representatives from HLEN, HLGP, NRR, and RES when, and if, we decide to proceed. (We asked NMSS/Fuel Cycles group to participate in the development and/or review of the TP. However, because of the current and anticipated future heavy work load, Fuel Cycles group has declined to participate.)

### 3. WHO SHOULD UNDERTAKE THIS WORK (NRC OR DOE)?

It is up to the DOE to conduct the design work. Therefore the NRC staff does not intend to tell DOE how to do the design work. The objective of the proposed TP is to provide guidance to DOE on what NRC would find acceptable to demonstrate compliance with 10 CFR Part 60 requirements pertaining to seismic and surface faulting design of GROA surface facilities. The scope of this technical position will include guidance on design of GROA surface facilities structures, systems, and components important to safety to ensure that design includes provisions to meet pre-closure performance objectives, and that seismic and faulting conditions anticipated at the site do not interfere with necessary safety functions of these facilities.

### 4. ROLE OF TP IN LICENSE REVIEW PROCESS

A Technical Position, rather than other forms of guidance (review plan or rulemaking), is considered appropriate for this topic as explained below. However, need to provide guidance in another format will be an option that will be evaluated when results from the development of ROC become available.

The design work by DOE is to be started quite early in the process, even before the site is found suitable for repository development and DOE's preparation of a license application. Therefore, a review plan would not be appropriate place for guidance on this issue. Also, a rulemaking is not considered necessary at this time because the subject matter deals with how DOE implements the existing regulatory requirements rather than a need for modification of 10 CFR Part 60 requirements. However, if the development of ROC indicates otherwise, a rulemaking can be initiated after a need for it is identified and the TP will be conformed to the proposed revised rule.

### 5. PROJECTED SCHEDULE FOR COMPLETION OF TP

We realize the importance of following the generic milestone schedule given in Appendix B of the WM Policy # 46 (Attachment 2). However, for developing a TP on this topic, longer time period may be needed because of the controversial nature of the TP, the need for its coordination with other offices (e.g., NRR, RES, etc.) and CNWRA, and finally, because the Section, although anticipated to be 40% understaffed, will attempt to undertake this unbudgeted work. Also,

coordination of this TP with ROC findings is considered extremely important and positions cannot be taken before ROC results are finalized. Accordingly, even though every attempt will be made to complete the final TP according to schedule given in attachment 2, a delay may however be anticipated.

#### 6. ANNOTATED OUTLINE OF THE PROPOSED TP

An annotated outline of the proposed technical position is being developed. It will follow the format given in Appendix C of the WM Policy # 46. A preliminary outline is given in Attachment 1 to this document.

#### 7. NEED FOR PRELIMINARY MEETINGS

We plan to develop the technical position with in-house resources with the help of experts in the structural engineering discipline at NRR and RES. We intend to ask the CNWRA to review the drafts of the TP. We anticipate the need for a few preliminary meetings within and outside of the NRC before the release of a draft TP. Specifically, meetings may be needed with CNWRA, OGC, NRR, RES, NMSS/Fuel Cycles and other NRC staff for consultation purposes. Specific dates and participants for these meetings will be identified after the completion of a review and approval of the scope of this document.

## ATTACHMENT 1

### ANNOTATED OUTLINE FOR TECHNICAL POSITION ON APPLICATION OF SEISMIC AND FAULTING DESIGN BASES TO ENGINEERING DESIGN OF GEOLOGIC REPOSITORY OPERATIONS AREA SURFACE FACILITIES

The following annotated outline is a very rough draft of the scope of the technical position to be developed. It is preliminary and incomplete at this stage and should be reviewed and commented upon as such. The final position will be developed after considering the review comments on this annotated outline. Suggestions to improve the scope and the technical position will be appreciated.

#### 1. INTRODUCTION

The purpose of this technical position (TP) is to provide guidance to the U.S. department of Energy (DOE) on the application of seismic and faulting design bases to engineering design of GROA surface facilities. Use of proper design method for the GROA surface facilities design is essential to ensure that the design meets the requirements of 10 CFR Part 60, including the requirement that the seismic and faulting conditions will not interfere with necessary safety functions of the structures, systems, and components important to safety.

The scope of the technical position will cover NRC staff guidance on an approach acceptable to the NRC staff for DOE's implementation of relevant 10 CFR Part 60 requirements on this subject. It is assumed that other technical positions being developed by HLGP staff would cover needed guidance to DOE on relevant topics up to the stage of developing seismic and surface faulting bases for design. The subject TP would cover guidance on topics including seismic input form, modelling for seismic system analyses, seismic analyses methods, modal damping, modal combinations, and load combinations. In addition, the TP would cover guidance on design basis for surface faulting.

Section 2 of the Technical Position will focus on specific applicable NRC regulations. In section 3 of the TP, the technical positions will be briefly and clearly stated. The discussion in section 4 of the TP will provide amplification of the positions stated. In the appendices to the TP, glossary terms will be defined as needed and an appendix will be reserved for resolution of public and ACNW comments and their resolution. The appendix on comment resolution will be prepared after comments on the TP Have been satisfactorily resolved.

Technical positions are issued to describe and make available to the public methods acceptable to the NRC staff for implementing specific parts of the Commission's regulations, or to provide guidance to the Department of Energy.

Technical Positions are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the position will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of an authorization or license by the Commission.

## 2. REGULATORY BACKGROUND

The criteria set forth in Subsection 60.21(c)(3) of 10 CFR Part 60 form the basis for seismic and surface faulting design of the GROA surface facilities. The following is the text of Subsection 60.21(c)(3):

The Safety Analysis Report shall include: A description and analysis of the design and performance requirements for structures, systems, and components of the geologic repository which are important to safety. This analysis shall consider - (i) The margins of safety under normal conditions and under conditions that may result from anticipated operational occurrences, including those of natural origin; and (ii) the adequacy of structures, systems, and components provided for the prevention of accidents and mitigation of the consequences of accidents, including those caused by natural phenomena.

In addition, the performance objectives and design criteria described in 10 CFR Part 60 establish the bases for considering the seismic and surface faulting design for the preclosure period.

According to 10 CFR 60.111, during the preclosure period, the geologic repository operations area is to be designed to provide protection against radiation exposures and releases of radioactive material in accordance with standards set forth in 10 CFR Part 20. Also, during the preclosure period, 10 CFR 60.111 requires that the option to retrieve the emplaced radioactive waste is preserved.

According to the general design criterion for the geologic repository operations area (GROA) in 10 CFR 60.131(a), the GROA shall be designed to maintain radiation doses, levels and concentrations of radioactive material in air in restricted areas within the limits specified in 10 CFR part 20.

According to the general design criterion for the GROA in 10 CFR 60.131(b)(1), the structures, systems, and components important to safety shall be designed so that natural phenomena and environmental conditions anticipated at the geologic repository operations area will not interfere with necessary safety functions.

## 3. TECHNICAL POSITIONS

Technical positions will be developed on the following topics:

### A. DESIGN METHOD FOR SEISMIC LOADING

1. Seismic Input: What form of seismic input is acceptable?

Once an earthquake level is defined by seismologists as appropriate for design of structures, the engineers use it as a dynamic load to determine deflections, stresses and moments in the building expected during earthquakes for designing the structure to withstand these effects. For reactor design, Regulatory Guide 1.60 provides guidance on the shapes of horizontal and vertical earthquake response spectra considered acceptable for design input. These shapes for horizontal ground motion as well as for vertical ground motion are very conservative. We will need to come up with some reasonable position.

For reactor design, Appendix A, 10 CFR Part 100, states that in the dynamic analysis of structures, earthquake design motion should be applied at the foundation level of the structure being designed. Again, this position generally results in very conservative forces for which structures have to be designed. An alternative position is to define the earthquake input at the ground surface level, which results in more reasonable analysis results. We will need to take a position on this issue.

Earthquake time histories compatible with the design response spectra are generally used as input for time-history seismic response analysis. The TP will need to identify procedures that are acceptable for time history generation.

2. Modeling for Seismic System Analysis: What mathematical models are acceptable for analysis?

Usually either the lumped mass model or the finite element model is used for mathematical modelling of structures to perform the seismic analysis. TP will need to take a position if either method of modeling is acceptable.

3. Seismic Analysis Methods: What method(s) of analysis would be considered acceptable for seismic design of GROA surface facilities?

The staff needs to take a position in the proposed TP on acceptable analysis procedures for evaluating response of structures. Generally, response spectrum technique is used for calculating the structural response and the time-history technique is used for generating floor response spectra for design of equipment.

Also TP needs to identify a position on the acceptability of frequency dependent and frequency independent parameters for foundation conditions.

4. Modal Damping: What modal damping values are acceptable for seismic analysis purposes?

The staff needs to take a position on the damping values that should be used for structural members in performing the seismic analysis. Generally damping values consistent with Regulatory Guide 1.61 are used for safety-related nuclear structures.

5. **Modal Combinations:** What methods are acceptable for combining modal responses in each direction?

Generally the methods proposed by American Society of Civil Engineers (ASCE) Seismic Analysis Standards Committee are used to combine modal response and to calculate total structural response from the analysis of two horizontal and one vertical direction. The TP needs to take a position on the acceptability of these methods.

6. **Load Combinations:** How the seismic analysis results will be combined with other structural loads to design the structures?

The TP needs to take a position on acceptable load factors for combining the applicable design loads.

#### B. DESIGN BASIS FOR SURFACE FAULTING

1. **Design Basis:** The TP will need to define the objective for designing against surface faulting.

The TP will need to take a position on the significance of the structures, systems, and components important to safety to remain functional in the event of displacement during surface faulting.

2. **Direction and Azimuth of Faulting:** The TP needs to take a position on randomness of the direction of the surface faulting for design purposes.

10 CFR Part 100, Appendix A, takes a position that the design provisions shall be based on the assumption that the design basis for surface faulting can occur in any direction and azimuth and under any part of the structure, unless evidence indicates this assumption is not appropriate, and shall take into account the estimated rate at which the surface faulting may occur. The TP will need to take a position on the validity of this design basis for GROA surface facilities.

#### 4. DISCUSSION

The technical positions in Section 3 above will be discussed in Section 4. The discussion will provide reasons and justifications for the positions. The positions will be discussed in the same order as they are presented in Section 3.

5. REFERENCES

1. 10 CFR Part 60.

2. MacDougall, H. R., et. al., "Site Characterization Plan Conceptual Design Report," SAND84-2641, September 1987.

APPENDICES

APPENDIX A: Comment Resolution.

This Appendix will be added after receipt of public and ACNW comments and their resolution.

## Attachment 2

STANDARD MILESTONES AND SCHEDULES FOR THE  
DEVELOPMENT OF TECHNICAL POSITIONS (TPs)

Milestone	Elapsed Time(wk)	Schedule	Accumulated Time(wk)	Date
Initiate need for TP	0		0	July 23, 1990
Obtain Program, Planning, and Status Assessment System (PPSAS) number	1		1	
Scope complete	8		9	
Determination on need for TP	1		10	
Notify special parties of the staff intent to issue a TP	3		13	
Preliminary meeting, if necessary	3		16	
Internal draft	16		32	
Internal NRC comments	4		36	
Public-comment draft	8		44	
<u>Federal Register Notice/</u> transmittal to Advisory Committee on Nuclear Waste	3		47	
Public comment period closed	8		55	
Evaluation of Comments and Revision of TP	6		61	
Public meeting on disposition of comments	2		63	
ACNW review	2		65	
Complete Final TP	4		69	
Issue Final TP	4		73	