Distribution:
WM file: 100
WMEG r/f
JTGreeves
MSNataraja
DCGupta
JRPearring
MBlackford

~~100/D60/05/770~~/0

JUL 09 1985

NOTE TO: Malcolm R. Knapp, Chief
Geotechnical Branch
Division of Waste Management

FROM: John T. Greeves, Chief
Engineering Branch
Division of Waste Management

SUBJECT: COMMENTS ON DOE's ANNOTATED OUTLINE OF RATIONALE FOR SEISMIC/TECTONIC INVESTIGATIONS FOR LICENSING A NUCLEAR WASTE REPOSITORY

A note dated June 28, 1985, from Philip Justus to me and other WM Branch Chiefs asked for comments by Seismic Hazard Evaluation Task Group members on the DOE's Annotated Outline of Rationale for Seismic/Tectonic Investigations for Licensing a Nuclear Waste Repository. Jerry Pearring and Dinesh Gupta of my staff have reviewed the subject document, and based on this review, have prepared the enclosed comments. If you have any questions on these comments, please contact Dinesh Gupta on x74742.

Original Signed By

John T. Greeves, Chief
Engineering Branch
Division of Waste Management

Enclosure:
As stated

WM Record File 109.3
WM Project 1
Docket No.
PDR ✓
LPDR
Distribution:
(Return to WM, 623-SS)

8509030049 850709
PDR WASTE
WM-1 PDR

OFC	:WMEG	:WMEG	:WMEG	:WMEG	:	:	:
NAME	:DCGupta:jec	:JRPearring	:MSNataraja	:JTGreeves	:	:	:
DATE	:07/09/85	:07/9/85	:07/09/85	:07/09/85	:	:	:

WMEG Comments on DOE's Annotated Outline of
Rationale for Seismic/Tectonic Investigations
for Licensing A Nuclear Waste Repository

1. Comment on Section II.B, "Definitions" (pages 3-4)

   The possible application of some of the terms identified in the provisional list of definitions is not clear. For example, the meaning and intent of the use of terms like Class I structure, Class II structure, Class III structure, Design earthquake I, Design earthquake II, Design UNE I and Design UNE II are not self-explanatory.

2. Comment on Section III.A, "Identification of Significant Processes and Events" (page 5)

   The section states that for each relevant seismic/tectonic process, the potential impact on pre-closure and post-closure performance objectives will be evaluated. However, these types of analyses would generally require DOE to have knowledge of the strength of facilities to resist a given magnitude of event. Since adequate information may not become available at the conceptual design stage, the DOE should explain, in detail, the methods proposed to evaluate the said impacts.

3. Comment on Section III.C.2, (last paragraph), "Issue Resolution Methodology" (page 8)

   The DOE's paper states that post-closure issues will involve 'groundwater travel time'. This statement is not consistent with 10CFR60.113 (a)(2), which requires consideration of pre-waste-emplacement groundwater travel time for locating the geologic repository.

4. Comment on Section VI.C, "Post-Closure" (page 16, first paragraph)

   The DOE's paper states that postclosure-release scenarios should examine the effects of seismic/tectonic phenomenon on three things: hydrology, integrity of waste package, and integrity of engineered-barrier system. However, these items do not include shafts, boreholes and their seals. The DOE should include these items on the list.

5. Additional comments are shown on the enclosed marked-up copy of the DOE's Annotated Outline of Rationale.

OFC	WMEG	WMEG	WMEG	WMEG			
NAME	DCGupta:jec	JRPearring	MSNataraja	JTGreeves			
DATE	07/ /85	07/ /85	07/ /85	07/ /85			

RATIONALE FOR SEISMIC/TECTONIC INVESTIGATIONS FOR LICENSING A NUCLEAR WASTE REPOSITORY

CONTENTS

CONTENTS (Cont'd)

OUTLINE

RATIONALE FOR SEISMIC/TECTONIC INVESTIGATIONS
FOR LICENSING A NUCLEAR WASTE REPOSITORY

I. INTRODUCTION

- Purpose: To develop and articulate an approach to resolve seismic and tectonic issues that is consistent with the requirements of 40 CFR 191, 10 CFR 60, and 10 CFR 960.

- General Framework: The Site Characterization Plan (SCP) is the document that will define the information needed, and the approach to obtaining that information, for ultimate use in the demonstration of compliance. The applicable regulations provide a framework of concepts to be addressed in the demonstration of compliance with the regulations but do not provide specific guidance as to their implementation. The implementation of the regulations requires an analytic exercise wherein the post closure and preclosure aspects of the regulations are examined in light of possible scenarios, site characteristics and known data to determine, in a preliminary fashion, those aspects of the site which could impact the eventual compliance demonstration. This information is used in the development of plans to acquire data during site characterization. This information also provides the base for the ongoing reevaluation of the approach to demonstrate compliance. It is expected that, as data from site characterization become available, scenario probabilities will be defined and necessitate redirection of field activities. One aspect of the above described process is concerned with seismic/tectonic phenomena. This paper will provide an approach and rationale for the seismic/tectonic investigations to be described in detail in Chapter 8 of the SCP; the content of the paper will be incorporated in or

What aspect are you referring to? I do not understand this sentence.

what site characteristics are you referring to. If you mean repository rock data this is nonsense as we will not gather any site data during site characterization that will increase our knowledge of how the openings, support sets or any aspect of the rock mass will react under a known event. We will only acquire knowledge during construction.

referenced by the SCP. General requirements for site characterization will be included in Chapter VII of this paper. The Safety Analysis Report (SAR) will demonstrate that the information obtained during site characterization and the methods and assumptions used ~~to perform~~ in performing safety analyses reflect reasonable assurance that performance objectives of 10 CFR 60 and radionuclide release standards of 40 CFR 191 have been met.

- o Approach: The approach to resolve seismic/tectonic issues must result in a repository site and design that is safe, environmentally acceptable, cost effective, and located such that credible seismic/tectonic phenomena will not degrade system performance below acceptable limits. Performance assessment, safety analyses, and repository performance confirmation monitoring are the means by which this is demonstrated. Specific distinctions should be made regarding the period of performance; repository preclosure considerations involve both surface and underground facilities during a relatively short operational period, whereas postclosure considerations involve only the underground facilities and geologic setting, but for a much longer isolation time frame. It is envisioned that early interaction with NRC will be required during the preparation of this paper to assure that the developed framework is acceptable.

II. APPLICABLE REGULATIONS AND DEFINITIONS

A. REGULATORY FRAMEWORK

This section will provide a discussion of, and establish the hierarchy for, the application of currently existing regulations relative to seismic/tectonic considerations in the licensing process. The Nuclear Waste Policy Act (NWPA) will be included to establish the procedural baseline for the regulatory process. The three remaining regulations with direct applicability, 40 CFR 191 (draft), 10 CFR 60, and 10 CFR 960 (and other incorporated regulations), will be reviewed and summarized, with focus on

citation of those sections containing seismic/tectonic criteria, or with seismic/tectonic implications.

B. DEFINITIONS

This section will provide a glossary of applicable definitions. Definitions that will be developed should be consistent with those already in existence, such as those found in 10 CFR 60, 10 CFR 960, and 40 CFR 191 (draft). If current wording is unclear for some definitions in existence (for example "active fault" in 10 CFR 960), an interpretation of the intent of the definition is necessary. Those definitions not found in the above regulations will be developed as appropriate. Inconsistencies will be identified and resolutions proposed.

A provisional list of definitions to be included follows:

Definitions

Accessible environment
Active fault
Annual Probability
Anticipated event
Candidate area
Class I structure
Class II structure
Class III structure
Controlled area
Complementary Cumulative Distribution Function (CCDF)
Design earthquake I
Design earthquake II
Design event
Design ground motion
Design spectra
Deterministic analysis
Disturbed zone
Design UNE I (Underground Nuclear Explosion)

Design UNE II (Underground Nuclear Explosion)
Exceedance probability
Expected respository performance
Geologic setting
Hydrologic terms (to be expanded)
Important to safety
Likely consequence of failure
Maximum consequence of failure
Mean return period
Mitigation
Performance assessment
Performance objective
Postclosure earthquake (PCE)
Probabilistic analysis
Probabilistic safety assessment (formerly probabilistic risk assessment)
Reasonably forseeable events
Reasonable assurance
Response spectrum
Retrievability
Scenario
Seismicity
Seismogenic province
Significant tectonic event
Site
Subsurface facilities (shallow and deep)
Surface facilities
Tectonic Processes
Unanticipated event
Very unlikely events

For definitions which are not included in 10 CFR 60, 10 CFR 960, and 40 CFR 191, use will be made, to the extent possible, of equivalent geological, industrial, and mathematical terms.

III. CONCEPTUAL APPROACH TO SEISMIC/TECTONIC ASSESSMENTS FOR LICENSING

A. IDENTIFICATION OF SIGNIFICANT PROCESSES AND EVENTS

1. This section will address the identification of seismic/tectonic processes and significant seismic/tectonic events which may influence safety considerations for the HLW repository regarding its total life cycle. Seismic/tectonic processes which should be considered include: a) volcanism, b) faulting (both fault rupture and earthquake ground motion), c) folding, and d) regional crustal movements and related stress accumulation . Significant seismic/tectonic events are those events which, in light of tectonic history and other characteristics of the site, must be considered in evaluating compliance of the repository with the performance objectives of 10 CFR 60. This may include human-induced ground motion and seismicity. Pre-closure and post-closure performance objectives, with respect to near-surface and subsurface, will require recognition of different sets of seismic/tectonic processes and events.

This section will address the formulation of probability based criteria to be used for identifying significant seismic/tectonic events to be considered for pre-closure analyses. On a preliminary basis it will identify seismic/tectonic processes which may be important with respect to these analyses. It will provide the rationale as to why certain processes should be included or excluded, based on either probability or consequences. Further, it will evaluate the potential impact of the relevant processes on pre-closure performance objectives, identify relevant seismic/tectonic processes and events, and reevaluate impact on repository design.

3. This section will identify those seismic/tectonic processes that are indicated by preliminary analyses to be of importance with respect to the post-closure analyses. It will provide the rationale as to why some processes should be included or excluded. For each relevant process it will evaluate potential impact, both direct and indirect, of this process on each post-closure performance objective. This section

will identify controlling seismic/tectonic events including their magnitude, and reevaluate impact on repository design and performance.

B. IDENTIFICATION OF THOSE ISSUES THAT NEED TO BE RESOLVED

Agree with B Wright. the use of the term issue here is not clear to the reader. Parameter?

This section will identify key issues from the current understanding of site behavior which require seismic/tectonic considerations for their resolution. It will provide the rationale for including and/or excluding certain issues.

Using the established hierarchy, the section will identify the issues that may require seismic/tectonic input. This section is to include: a) performance assessment issues, b) design issues, and c) site characterization issues, and provide the rationale for including and/or excluding certain issues.

For each pertinent issue, the section will identify seismic/tectonic processes and events that must be considered in order to resolve the issue properly. It will provide the rationale and evaluate the potential design and performance impacts.

C. ISSUE RESOLUTION METHODOLOGY

The resolution of pre-closure and post-closure seismic and tectonic issues may require different experimental and analytical techniques because of the different health and safety concerns and the different time periods involved.

1. Pre-closure issues will involve health and safety during operations and retrieval over periods of time up to 100 years. This section will identify specific techniques used for safety analysis, including seismic safety analysis. It will identify specific seismic/tectonic events which, at this time, are considered for the analysis and identify uncertainties and assumptions used in analyses.

The approach to demonstrating compliance could include the following steps:

a. Identify the set of release scenarios for anticipated seismic/tectonic processes and events that might affect safety during operation and retrieval.

b. Conduct failure mode analysis of structures, systems and components important to safety, using event probabilities and seismic design parameters determined according to procedures outlined in Chapter IV C and V B.

c. Determine likely and maximum consequences of failure with respect to radiological safety, considering ranges of parameters that affect these consequences.

d. Analysis of (c) and degree of compliance with release limits.

e. Consideration of uncertainty involved in analyses and effect on (d). Evaluation of impact on design of structures, systems, and components important to safety, and implications regarding design of structures to resist failure.

2. Post-closure issues will involve health and safety concerns for a period up to 10,000 years. Significant post-closure releases arising from seismic/tectonic phenomena must be included in the total system performance assessment that leads to the construction of the empirical Complementary Cumulative Distribution Function (CCDF) described in draft 40 CFR 191. This approach to demonstrating compliance could include the following steps:

a. Identify the set of release scenarios, including scenarios involving seismic/tectonic events and processes for both anticipated and, as appropriate, unanticipated events.

b. Construct mathematical models of each class of scenario; the models predict cumulative release of radioactivity from each class of scenario for the first 10,000 years after closure.

c. Assign probability distributions to the uncertain parameters that appear in the models of the scenarios; these distributions should be based on data pertaining to site tectonics and seismicity as much as possible.

d. Combine mathematical models in a single model, capable of time-dependent simulation, that gives sample values of the total cumulative release to the accessible environment 10,000 years after closure.

e. Exercise the model formed in "d", above, to obtain statistics sufficient to construct the CCDF mentioned in draft 40 CFR 191.

Additionally, post-closure issues will involve other 10 CFR 60 performance objectives. These are groundwater travel time, release rates from engineered barriers, and life of waste package. Resolution of these issues may require seismic/tectonic consideration. The paper will identify those issues and corresponding seismic/tectonic factors. It will identify the analytical techniques to be used; specific seismic/tectonic events which, at this time, are considered in this analysis; and assumptions and uncertainties.

IV. APPROACH FOR IDENTIFYING SIGNIFICANT SEISMIC/TECTONIC EVENTS

A. GENERAL

Preliminary scoping analyses should be performed to identify some or all of the significant seismic/tectonic events. These scoping evaluations should be made in accordance with "B", "C", "D" and "E" below.

B. SUMMARY OF EXISTING DATA BASE RELATED TO SEISMIC/TECTONIC EVENTS

This action will present a synopsis of the current data base; it will also present sets of field observations which a) are subject to alternative interpretations and/or b) may have a significant impact on waste containment and isolation. Included are the following topics:

1. Preclosure (10 CFR 960.5-2-11)

   a. Historical patterns of seismicity (including relationship to known surface features, indications of stress state).

   b. Relief and accumulation of tectonic stress and its effect on emplacement or retrieval operations.

   c. Fault displacement and its effects on: surface and subsurface facilities judged important to safety; operations; and retrieval.

   d. Effects of vibratory ground motion, natural or man induced, on surface or subsurface facilities that are judged important to safety.

2. Postclosure (10 CFR 960.4-2-7)

   a. Tectonic stress (its nature, i.e., tectonic, remnant, residual and gravitational components; orientation and magnitude temporal and spatial variability);

   b. Fault displacement (location, length of surface rupture, movement style and history, amount of slip, secondary effects);

   c. Vibratory ground motion; acceleration and response spectra; time history; relationship to (a) and (b);

d. Volcanism (composition, volume, time-space trends, tectonic setting, relationship to seismicity, geophysical data, eruptive mechanisms, secondary effects);

e. Human induced seismicity and ground motion (size and characteristics of the effect from UNE testing, fluid injection, fluid withdrawal, impoundment, and mining);

f. Secondary effects of seismic/tectonic events (ground-water movement, secondary slip and fracturing, landslides, liquefaction, and erosion);

g. Regional crustal movements and effects on waste isolation (folding, subsidence, uplift, diapirism).

C. ASSESSMENT OF SIGNIFICANCE

Based on professional judgment, including case histories from the region, and performance assessment calculations if available, this section will evaluate significance of the above topics in the context of each performance objective of 10 CFR 60. It will consider the pre-closure time-frame, i.e., operational releases and retrievability; and post-closure, i.e., compliance with 40 CFR 191 release standard, travel time, life of waste package and release rates from engineered barrier.

For the post-closure time frame considerations may include:

1. Relief and accumulation of tectonic stress and its effects on fracture conductivity, permeability, and pore pressure, waste-package integrity, and possible deterioration of seal performance.

2. Fault displacement and its effects on the permeability, fracture, conductivity and pore pressure, waste-package integrity, and disruption of seals.

against any uncertainty. We need to know more about rock mass properties in the free field first.

3. Effects of vibratory ground motion on permability, fracture conductivity, pore pressure, and water movement.

4. Magmatic intrusion or extrusion into the repository proper.

5. Magmatic intrusion or extrusion into the hydrologic system up and down-gradient of the repository and its affect on compliance with 10 CFR 60 performance objectives, and compliance with 40 CFR 191 release standards.

D. UNCERTAINTY CONSIDERATIONS

Assessments of safety must consider the extent of uncertainty that exists throughout any analysis and determine its effects on the conclusion reached in that analyses. Potential sources of uncertainty arise from: understanding of basic phenomena; formulation of constitutive relationships and conceptual models of features events and processes; formulation and execution of mathematical models; and date and date analysis. This section will address the manner by which uncertainty will be reduced in the following arrangement:

1. Conceptual uncertainty.

The physical reality is unmeasurable so the fidelity of models to it is only a guess.

Reduce conceptual uncertainties (i.e. fidelity of models to physical reality) through concensus opinion and through consideration of alternative hypotheses, if significant effect on results is shown.

2. Natural uncertainty.

Reduce numerical uncertainties through the use of site-specific data and concensus opinion. Appropriate numerical and analytical models will be used.

Rock characteristics site specific data from the geologic exploration well only be available during construction.

Validation can only be accomplish in a very limited way. Experimental observations can only be accomplished during and after construction and then only within the testing zone. Experimental observations in the free field would never be feasible as it would disturb the rock. We can verify the formula and code with one another "benchmarking" but we will never validate these codes

3. Interpretative uncertainty

Discuss how interpretative uncertainty can be reduced by carefully checking and validating formulae and codes; this is the focus of software QA programs advocated by NRC and DOE.

E. RELEVANCE OF EXPECTED EVENTS DURING PRE- AND POSTCLOSURE TIME FRAMES AND IMPACTS ON REPOSITORY DESIGN AND PERFORMANCE.

A comparative evaluation of the significant effects will be provided to offer a perspective on the most important aspects with respect to radiological safety and cost.

V. STRATEGY FOR ISSUE RESOLUTION AND/OR MITIGATION

A. GENERAL

This section will describe the licensing strategy to be employed in resolution of issues related to seismic/tectonic characteristics of the site. It will consider: a) procedures to be used in developing the seismic design parameters; b) engineering design measures; and c) recognition and integration of uncertainties. These measures involve in-depth consideration of possible means of adding confidence in the resolution of issues.

B. SEISMIC DESIGN PARAMETERS

This section will address procedures used to develop seismic design parameters;

Pre-closure - Identify procedures which are judged to be proper for use in developing seismic design parameters. The section will consider vibratory ground motion and surface rupture. It will discuss implementation of the scheme or procedure for classification of structures, systems and components deemed important to safety, and consider complementary

earthquake approaches acceptable for other nuclear facilities. The section will discuss the rationale, alternatives and procedures used for equivalent considerations in other industries.

Post-closure - This section will ascertain the sensitivity of the closed repository to vibratory ground motion and fault displacement, including secondary effects such as impacts on the ground water system. It will consider sealing, waste package, and other engineered and natural barriers. It will present procedures which could be used to develop seismic design parameters for post-closure.

C. ENGINEERING

For certain seismic/tectonic processes and events, a demonstration of compliance with some performance objectives could be achieved through conservative engineering design. This section will identify, in a preliminary fashion, these processes and events and the performance objectives corresponding to them. With respect to mitigation of undesired effects of each seismic/tectonic process and event it will identify available technology, engineering strategy and cost considerations. The discussion will consider allowable thermal loading and relate it to the size of the disturbed zone, mode of emplacement, clearance for tunnels, shafts and emplacement boreholes, etc., location of surface facilities, and design parameters for vibratory ground motion, including support considerations. The section will discuss the iterative aspects assessing compliance and refining design.

D. RECOGNITION AND MITIGATION OF UNCERTAINTIES

This section will discuss the manner in which the following topics are treated:

1. Assessment of uncertainties in event scenarios, conceptual models, mathematical models, and data.

Sources of uncertainty in each category will be identified as considered in analyses, because these will detract from the demonstration of reasonable assurance.

2. Enhance understanding of potentially adverse and favorable site conditions.

   The extent to which potentially adverse and favorable site conditions exist will be evaluated with respect to safety, environment, and cost. The reasonable assurance concept will be employed in judging if sufficient information exists to make decisions leading to licensing. Where information is shown to be inadequate, additional site characterization will be required.

3. Cost impacts as a function of variability.

   An assessment will be performed to evaluate the impact of variability in the estimated or calculated value of seismic loadings on the total cost of the repository. This section will consider appropriate variability of frequency and response spectra within an acceleration range; high frequency and low frequency ground motion will be considered. This section will also consider the cost increments for designing and constructing surface and underground facilities against failure induced by surface rupture.

4. Institute conservatism in operating procedures.

   This section will identify and discuss the operating procedures that may be developed to mitigate the impacts of seismic/tectonic hazards. It will evaluate the effectiveness of these procedures.

5. Institute Performance Confirmation Monitoring Program. This section will describe the monitoring and evaluation for specific performance parameters that will validate conclusions and assumptions made in the

SAR. It will discuss how results will lend confidence to decisions, especially the possible requirement for retrieval.

VI. SEISMIC/TECTONIC EVENTS AND RADIONUCLIDE RELEASE SCENARIOS

A. GENERAL

For each significant seismic/tectonic event as determined in Chapter IV, and with reference to the corresponding performance objective, present results of preliminary performance computations and plans for the final performance assessment. Consider both preclosure and postclosure time frames.

B. PRECLOSURE

For pre-closure the analysis shall include:

1. Scenario identification and analysis;

2. Failure Mode Analysis and design sensitivity;

3. Likely and maximum consequence determination;

4. Analysis of safety and compliance with release limits;

5. Uncertainty assessment.

C. POSTCLOSURE

For post-closure, the analysis shall include:

1. Scenario identification and analysis, emphasizing all aspects of hydrology and radionuclide travel;

2. Likely and maximum consequence determination;

3. Analysis of compliance with release limits;

4. Uncertainty assessment.

The identification of postclosure-release scenarios involving seismic/tectonic phenomenon should proceed by examining the effects of such phenomenon on three things: the hydrology and radionuclide transport aspects of the site; the integrity of the waste package; and the integrity of the engineered-barrier system.

The magnitude and consequences of the effects identified above should be used to further screen release scenarios; this may require calculations of likely and bounding consequences in terms of release from the barriers (waste package, engineered-barriers and the site) to establish their significance.

Special-purpose mathematical models of the significant classes of scenarios identified above should be constructed and combined with the model for expected releases to form a total systems model that can be used to simulate the behavior of the site/repository system under all anticipated, significant events and processes for the next 10,000 years.

VII. REQUIREMENTS FOR SITE CHARACTERIZATION INCLUDING METHODOLOGY AND CRITERIA APPROPRIATE FOR RESOLUTION OF SEISMIC AND TECTONIC ISSUES.

A. TYPES OF ISSUES AND RELATIONSHIP TO REPOSITORY DEVELOPMENT SCHEDULE

The complete set of characterization issues for the project has been derived from considerations of performance and design (10 CFR 60) as well as consideration of siting criteria in 10 CFR 960. This issues hierarchy is an essential prerequisite in identifying data and information needs to be provided during the site characterization process. The site characterization plan (SCP) is being developed to be compatible with the

data and information needs. The data and information must be obtained in a timely manner in order to meet the DOE repository development schedule as required by NWPA.

Within the overall issue hierarchy, some issues specifically address seismic/tectonic concerns, an example is Mission Plan Issue 4.5 relating to the tectonic compatibility of the site with repository construction, operation, and closure. Conversely, there are a number of issues in which the influence of seismic/tectonic processes or events is indirect but is important to resolution.

This section will identify data and information needs related to seismic/tectonic processes or events which, at this time, are judged to be required for satisfactory resolution of each pertinent issue. It will consider all aspects of the issue resolution process, including: a) site characterization; b) engineering design; c) performance assessment; and d) performance confirmation monitoring.

For each issue requiring seismic/tectonic considerations identify when, in relation to the DOE's repository development schedule, evaluation of this issue should be completed.

B. DATA AND INFORMATION NEEDS

This is written in a much too general way. It does not recognize the unavailability of the data that is required to accomplish the various tasks identified

1. Site Characterization

The impact on containment and isolation is not a single valued parameter its value depends on factors which are as of unknown and upon imposed field thermal density which also is as yet unknown.

Seismic/tectonic data and information needs to be satisfied during the site characterization process pertain to three broad categories. These are: a) for each seismic/tectonic process, estimates of probability of occurrence of a given tectonic event; b) impact of this event on containment and isolation; and c) parameters, i.e., physical properties and boundary conditions, which are required in order to quantify impact of this event on a given performance objective. Identify data and information needs as they pertain to these categories and each

The physical properties of the rock mass will never be known and thus the values needed to verify design will not be available until construction. This section was written in a manner embraced by fact.

applicable site characterization issue. Consider both pre-closure and post-closure performance objectives.

2. Performance Assessment

The performance assessment aspect of the issue resolution process will require its own set of data and information needs related to seismic/tectonic conditions. These may be related to a) evaluating significance of a given tectonic process to waste containment and isolation, e.g., phenomenological understanding of impact of basaltic intrusion and/or faulting on ground-water travel time and/or post-closure releases of radioactivity; b) identification of parameters, i.e., properties and boundary conditions, required for quantification of impact of a given tectonic process with respect to a given performance objective; c) evaluating relationship between impact and size of a given seismic/tectonic event; and d) constitutive relation and model validation. Identify data and information needs for each pertinent performance issue. Consider both pre-closure and post-closure time spans and performance objectives.

The process is iterative in that preliminary models, codes and scenario are used to identify information needed for licensing; as data becomes available from site characterization, models will be refined, codes will become more sophisticated and scenario probabilities will be defined. This could lead to the redefinition of information needed from site characterization. The process results in a defensible performance assessment of the site which forms the basis for demonstration of compliance with the applicable regulations.

3. Design

Identify elements of conceptual design which require seismic/tectonic consideration. Identify range of design options and discuss licensing and cost implications. Identify data and information needs related to seismic/tectonics and which are required in order to demonstrate that a given design decision is adequate. This decision may include: design

parameters, method of construction, location, and material. Consider pre-closure and post-closure aspects of repository design and performance.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Based on analysis and interpretations performed in order to develop this position paper, identify perceived seismic/tectonic events or processes, if any, which represent areas of significant concern in the licensing process. Recommend areas and methods of investigation leading to resolution.