DEC 12 1991

SEISMO STP/ACNW

MEMORANDUM FOR: Raymond F. Fraley, Executive Director
Advisory Committee On Nuclear Waste

THRU: Abraham L. Eiss, ACNW Liaison
Special Issues Group
Office of Nuclear Material Safety
and Safeguards

FROM: B.J. Youngblood, Director
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: TRANSMITTAL OF BRIEFING CHARTS TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW) FOR THE DECEMBER 1991 BRIEFING

In preparation for the 38th meeting of the ACNW, the Division of High-Level Waste Management hereby transmits copies of the briefing charts it will use when briefing the ACNW on the proposed final draft staff technical position entitled "Investigations to Identify Fault Displacement and Seismic Hazards at a Geologic Repository" (see enclosure 1). Also included are the briefing charts the staff will use when it meets with the ACNW's Working Group on concerns related to seismic and faulting investigations for a geologic repository on December 17, 1991 (see enclosure 2).

If you have any questions or desire additional information, please contact the Project Manager for this STP, Michael P. Lee, at extension 20421.

Original Signed by

B.J. Youngblood, Director
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosures (2): As stated

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ENCLOSURE 1

PRESENTATION TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE

STAFF TECHNICAL POSITION ON INVESTIGATIONS TO IDENTIFY FAULT DISPLACEMENT AND SEISMIC HAZARDS AT A GEOLOGIC REPOSITORY

STAFF TECHNICAL POSITION ON INVESTIGATIONS TO IDENTIFY FAULT DISPLACEMENT AND SEISMIC HAZARDS AT A GEOLOGIC REPOSITORY

INTRODUCTORY REMARKS: RONALD L. BALLARD

STRATEGY FOR GUIDANCE ON TECTONICS: SEISMIC HAZARDS, FAULTING, TECTONIC MODELS AND APPICATION TO DESIGN
PHILIP S. JUSTUS

DISCUSSION OF STAFF TECHNICAL POSITION: HISTORY OF STP AND SCOPE
PHILIP S. JUSTUS

OBJECTIVES, CONCEPTS OF INVESTIGATIONS OF FAULT-DISPLACEMENT HAZARD
KEITH I. McCONNELL

INVESTIGATIONS FOR VIBRATORY GROUND-MOTION HAZARD
ABOU-BAKR K. IBRAHIM

SIGNIFICANT CHANGES TO STP IN RESPONSE TO COMMENTS
KEITH I. McCONNELL & ABOU-BAKR K. IBRAHIM

ACNW PRESENTATION DECEMBER 18, 1991

PRESENTATION TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE
DECEMBER 18, 1991

Ronald L. Ballard
Division of High-Level Waste Management

INTRODUCTORY REMARKS

PRESENTATION TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE
DECEMBER 18, 1991

Philip S. Justus
Division of High-Level Waste Management

STRATEGY FOR GUIDANCE ON TECTONICS: FAULTING AND SEISMIC HAZARDS, TECTONIC MODELS AND APPLICATION TO DESIGN

OBJECTIVES OF DHLWM GUIDANCE

HELP ENSURE DOE'S PROGRAM IS SUFFICIENT TO:

- IDENTIFY AND ADDRESS LICENSING ISSUES EARLY
- PROVIDE APPROPRIATE INPUT TO ASSESSMENTS
- PROVIDE BASELINE DATA
- DEVELOP COMPLETE LICENSE APPLICATION

SELECTION OF TECTONICS GUIDANCE TOPICS

- INPUT SOURCES
  - STAFF EVALUATION OF REGULATIONS ADDRESSING TECTONICS
  - STAFF EVALUATION OF DOE'S PROGRAM
  - DOE'S REQUEST FOR GUIDANCE
- OUTPUT
  - FAULTING HAZARD
  - SEISMIC HAZARD
  - TECTONIC MODELS
  - APPLICATION TO DESIGN

REGULATIONS REQUIRING ASSESSMENT OF TECTONICS
10 CFR PART 60

SITING CRITERIA	(60.122)
DESIGN CRITERIA	(60.130-135)
PERFORMANCE OBJECTIVES	(60.111-113)
40 CFR PART 191 (CONFORMED)	(60.112)
TECHNICAL ASSESSMENTS	(60.21)
PERFORMANCE CONFIRMATION	(60.140-141)

DOE REQUEST FOR GUIDANCE ON TECTONICS ITEMS
(2/27/90)

FAULTING HAZARD

** IDENTIFICATION OF SIGNIFICANT QUATERNARY FAULTS
** CRITERIA FOR DETERMINING WHICH FAULTS OR FEATURES TO CHARACTERIZE

- SUBSURFACE FAULT GEOMETRIES
- FAULT SEGMENTATION
- FAULT LENGTHS AND WIDTHS
- FAULT SLIP RATES
- DISPLACEMENT ASSOCIATED WITH DISCRETE FAULTING EVENTS
- SUBSIDIARY FAULTING

** ADDRESSED IN STP ON INVESTIGATIONS TO IDENTIFY FAULT DISPLACEMENT AND SEISMIC HAZARDS

DOE REQUEST FOR GUIDANCE ON TECTONICS ITEMS
(2/27/90)

SEISMIC HAZARD

- MAGNITUDE-FREQUENCY RELATIONSHIPS
- NO-POISSONIAN RECURRENCE MODELS
- CHARACTERISTIC EARTHQUAKES
- MAXIMUM-MAGNITUDE EARTHQUAKES
- GROUND-MOTION ATTENUATION RELATIONSHIPS
- GROUND-MOTION SITE EFFECTS
- EXCEEDANCE PROBABILITIES FOR GROUND-MOTION PARAMETERS

DOE REQUEST FOR GUIDANCE ON TECTONICS ITEMS
(2/27/90)

TECTONIC MODELS

- ALTERNATE TECTONIC MODELS

ANALYSIS METHODS

- CONSERVATISMS AND NON-CONSERVATISMS IN ANALYSES
- PARAMETER UNCERTAINTIES
- SENSITIVITY OF HAZARD ESTIMATES IN DESIGN

APPLICATION OF HAZARDS TO DESIGN

- ANTICIPATED USAGE OF HAZARD ESTIMATES IN DESIGN

TOPICS FOR GUIDANCE ON TECTONICS

1. INVESTIGATION OF FAULT DISPLACEMENT AND SEISMIC HAZARDS [TOPIC FOR TODAY'S MEETING]

2. ANALYSIS OF FAULT DISPLACEMENT AND SEISMIC HAZARDS

3. USE OF TECTONIC MODELS

TOPIC UNDER CONSIDERATION

4. APPLICATION OF FAULT DISPLACEMENT AND SEISMIC HAZARD TO REPOSITORY DESIGN

1. STP - INVESTIGATIONS TO IDENTIFY FAULT DISPLACEMENT AND SEISMIC HAZARDS [TOPIC FOR TODAY'S MEETING]

SCOPE OF STP

- METHODOLOGY TO IDENTIFY FAULT DISPLACEMENT AND SEISMIC SOURCES
- METHODOLOGY TO IDENTIFY FAULTS SUSCEPTIBLE TO DISPLACEMENT
- RESPONSE TO DOE REQUEST FOR GUIDANCE

PRINCIPAL PART 60 REQUIREMENTS

- 60.21(c)(1)(ii) ANALYSIS OF GEOLOGY AND GEOPHYSICS
- 60.122(A)(2) ADEQUATE INVESTIGATIONS
- 60.131(b)(1) PROTECT SSCIS AGAINST NATURAL PHENOMENA

STATUS

- FINAL STP EARLY CY92

2. STP - ANALYSES OF FAULT DISPLACEMENT AND SEISMIC HAZARDS

SCOPE OF STP

- ACCEPTABLE ANALYSIS METHODOLOGY
- RESPONSE TO DOE'S REQUEST FOR GUIDANCE
- DETERMINISTIC SUPPLEMENTED BY PROBABILISTIC
- FAULT DISPLACEMENT INPUT TO REPOSITORY DESIGN AND PERFORMANCE

PRINCIPAL PART 60 REQUIREMENTS

- 60.112 MEET EPA STANDARD
- 60.113 MEET SUBSYSTEM PERFORMANCE OBJECTIVES
- 60.122(a)(2) ANALYSES NOT TO UNDERESTIMATE EFFECTS
- 60.131(b)(1) MAINTAIN SAFETY FUNCTIONS

STATUS

- DRAFT FOR PUBLIC COMMENT FY93

3. STP - USE OF TECTONIC MODELS

SCOPE OF STP

- ACCEPTABLE APPROACHES FOR SUPPORTING AND IMPLEMENTING PREDICTIVE MODELS
- RESPONSE TO DOE'S REQUEST FOR GUIDANCE

PRINCIPAL PART 60 REQUIREMENTS

- 60.21(c)(1)(ii)(F) EXPLAIN SUPPORT FOR MODELS

STATUS

- PENDING ISSUANCE OF EPA STANDARD

GUIDANCE ON APPLICATION OF FAULT DISPLACEMENT AND SEISMIC HAZARDS TO DESIGN

SCOPE UNDER CONSIDERATION

- ACCEPTABLE METHODS OF COMPLIANCE WITH DESIGN CRITERION - 60.131(b)(1)
- ACCEPTABLE METHODS OF COMPLIANCE WITH CERTAIN PORTIONS OF 60.113(A),(B)

PRINCIPAL PART 60 REQUIREMENTS

- 60.21(c)(3) ANALYSIS OF DESIGN
- 60.111 PRECLOSURE PERFORMANCE OBJECTIVES
- 60.131(a) GENERAL DESIGN CRITERIA FOR GROA
- 60.131(b)(1) MAINTAIN ESSENTIAL SAFETY FUNCTIONS
- 60.113(a)(iii)(A),(B) PERFORMANCE OF PARTICULAR ENGINEERED BARRIERS AFTER PERMANENT CLOSURE

STATUS

- UNDER CONSIDERATION

PRESENTATION TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE
DECEMBER 18, 1991

Keith I. McConnell, Abou-Bakr Ibrahim, and Philip S. Justus
Division of High-Level Waste Management

STAFF TECHNICAL POSITION ON INVESTIGATIONS TO IDENTIFY FAULT DISPLACEMENT AND SEISMIC HAZARDS AT A GEOLOGIC REPOSITORY

CHRONOLOGY OF DEVELOPMENT

PUBLIC COMMENT DRAFT TP ISSUED	AUGUST 1989
DOE/NRC TECHNICAL EXCHANGE ON DRAFT TP ON METHODS OF EVALUATING SEISMIC HAZARD AT A GEOLOGIC REPOSITORY	DECEMBER 1989
DOE/NRC TECHNICAL EXCHANGE ON TECTONICALLY SIGNIFICANT FAULT	JUNE 1990
DOE/NRC TECHNICAL EXCHANGE ON STP	FEBRUARY 20, 1991
PUBLIC COMMENT DRAFT STP ISSUED	MAY 13, 1991
ACNW WORKING GROUP/FULL COMMITTEE MEETINGS ON FINAL DRAFT STP	DECEMBER 17-18, 1991
ISSUE FINAL STP	EARLY CY 1992

PRINCIPAL DIFFERENCES BETWEEN TP AND STP

DRAFT TP:

EMPHASIZED SEISMIC HAZARD

APPEARS TO REQUIRE 10 CFR 100, APPENDIX A

STP:

INCLUDES BOTH FAULTING AND SEISMIC HAZARD

MAKES CLEAR THAT APPENDIX A IS NOT ADOPTED AND STATES WHY

MAKES CLEAR THAT PROCESSES TO IDENTIFY HAZARDS MAY NOT BE ENTIRELY DETERMINISTIC

OBJECTIVE OF STP

- PROVIDE AN ACCEPTABLE APPROACH TO INVESTIGATIONS FOR COLLECTION OF SUFFICIENT DATA FOR INPUT INTO FAULT DISPLACEMENT AND SEISMIC HAZARD ANALYSES FOR BOTH THE PRECLOSURE AND POSTCLOSURE PERIODS OF PERFORMANCE

USE OF THE TERM "SUSCEPTIBLE FAULT"

- Uncomfortable with the name "susceptible" fault. Concerned that unique terminology may be developed for different applications (i.e., nuclear power stations vs. radioactive waste disposal) (App. E, AEG comment #2).
- DOE believes the technical basis for the STP has not been demonstrated. STP appears to suggest that an unacceptable risk would exist if a fault with certain characteristics was not investigated in detail. No technical basis for the approach has been provided (App. E, DOE comment #2).
- The concept of "susceptible" faults has not been reviewed by the geologic community (App. E, DOE comment #6, NEV comment #3).
- The use of the term "susceptible fault" is vague, prejudicial, and misleading (App. E, EEI/UWASTE).

NEED FOR THE STAFF TECHNICAL POSITION

- Additional guidance on data needs for fault displacement and seismic hazards is unnecessary because published plans are adequate and will ensure a safe seismic design (App. D, DOE)
- The subject STP and planned STP's on tectonic and seismic issues should be held in abeyance until:
  a) DOE's position paper on earthquake investigations is issued;
  b) ASCE's Guideline for High-Level Waste Repository Seismic Design is issued;
  c) the revision to the seismic and geological siting criteria for nuclear power plants is promulgated
  (App. E, DOE comments #1 and #5).
- Methodology in STP would unnecessarily limit DOE's ability to focus its resources on those activities that will most effectively reduce uncertainties (App. E, DOE comment #4).
- STP does not provide sufficient guidance such that the site characterization program will provide appropriate and acceptable information (App. E, NEV comment #9).

GEOLOGIC SETTING CONCEPT

- STP indicates that guidance is most applicable for sites west of the Rocky Mountain Front, what guidance is given for other sites (App. E, AEG comment #2).
- Some consideration may be appropriate to allow for faults that cannot be found, as was the case at Coalinga (App. E, AEG specific comment #1)
- The STP fails to define criteria for a reasonable process to determine what constitutes the geologic setting (App. E, NEV general comment #1).
- STP could be substantially improved if more definitive statement is made on what the staff considers the geologic setting at Yucca Mountain to be (App. E, NEV specific comment #3).

COMPANION DOCUMENT

- Issues contained in the companion document for guidance on methods of analyses of fault displacement and seismic hazards may be more controversial than those in this STP (App. E, AEG comment #1).
- The STP applies only to site investigations and not to analysis or repository design. This division is artificial and inappropriate (App. E, EEI/UWASTE).
- The guidance document on methods of analyses of fault displacement and seismic hazards has not been provided. Without the companion document, it is difficult to understand the context and significance of the investigative methodology (App. E, NEV comment #7).

APPENDIX A TO 10 CFR PART 100

- The staff should explicitly and clearly state that Appendix A to 10 CFR Part 100 is not applicable to repositories and set forth why (App. E, EEI/UWASTE).

STRESS FIELD

- Definition of stress regimes is inherently uncertain. Differentiating existing and paleo-stress regimes is particularly dificult ; guidance is needed on this issue (App. E, AEG specific comment #11).
- It is presently an open question whether the existing stress regime can be defined given the complexity of the geologic setting (App. E, NEV specific comment #27b).

FAULT LENGTH

- Fault (size) length as a singular criterion for assessing the significance of susceptible faults may not be sufficient for the recognition and estimation of seismic hazard at and near the site (App. E, NEV comment #5).
- Dependence solely on the mapped length of individual faults or fault segments in the region may well underestimate the maximum size earthquake that can be associated with the mapped faults (App. E, NEV comment #16).

SIGNIFICANT CHANGES TO STP IN RESPONSE TO COMMENTS

- Recognition that additional guidance regarding the definition of the geologic system, faulting-component setting, and seismicity-component setting is needed.

- Modified the text to reflect the difference between what information is "relevant and material" and what information is "material and relevant."

ENCLOSURE 2

PRESENTATION TO THE ACNW WORKING GROUP

STAFF TECHNICAL POSITION ON INVESTIGATIONS TO IDENTIFY FAULT DISPLACEMENT AND SEISMIC HAZARDS AT A GEOLOGIC REPOSITORY

PRESENTATION TO ACNW WORKING GROUP
DECEMBER 17, 1991

Keith I. McConnell
Abou-Bakr Ibrahim
Division of High-Level Waste Management

RESPONSES TO COMMENTS ON THE STAFF TECHNICAL POSITION: INVESTIGATIONS TO IDENTIFY FAULT DISPLACEMENT AND SEISMIC HAZARDS AT A GEOLOGIC REPOSITORY

LIST OF ORGANIZATIONS PROVIDING COMMENTS

- ASSOCIATION OF ENGINEERING GEOLOGISTS
- EDISON ELECTRIC INSTITUTE/UTILITY NUCLEAR WASTE AND TRANSPORTATION PROGRAM
- STATE OF NEVADA
- U.S. DEPARTMENT OF ENERGY
- U.S. GEOLOGICAL SURVEY

TYPE OF COMMENTS RECEIVED ON DRAFT STP

TYPE OF COMMENT	NUMBER
REQUESTS FOR CLARIFICATIONS	44
DETERMINISTIC/PROBABILISTIC TECHNIQUES	11
USE OF THE TERM "SUSCEPTIBLE FAULT"	5
QUESTIONING NEED FOR THE STP	5
GEOLOGIC SETTING CONCEPT	5
COMPANION GUIDANCE DOCUMENT (ANALYSIS STP)	4
REFERENCE TO 10 CFR PART 100, APPENDIX A	4
STRESS FIELD	2
FAULT LENGTH	2

CLARIFICATIONS AND/OR MODIFICATIONS

- Requests or suggestions for clarifications, modifications, or additional guidance (App. D, DOE, App. E, AEG specific comment #2).
- Requests for additional background documentation/rationale behind technical positions (App. E, NEV specific comment #22a, DOE comment #1 (selected)).
- Positive comments in support of technical positions (App. E, AEG general comment #1, USGS overall comment).
- Neutral comments -- no requests for changes, clarifications or modications (App. E, NEV general comment #4 and specific comment #32).

DETERMINISTIC AND PROBABILISTIC TECHNIQUES

- Disagree with the concept that probabilistic techniques be avoided because they are not sufficiently conservative to identify faults requiring detailed investigation (App. E, AEG comment #4).
- A responsible method of assessment can be accomplished with a probabilistic technique. Empirical relationships form the foundation for a probabilistic approach (App. E, AEG comments #6 and #7).
- The STP rejects, without technical basis, the use of probabilistic techniques in determining which faults require detailed investigation. Appendix A to 10 CFR 100 is likely to endorse a combination of probabilistic and deterministic approaches (App. E, DOE comment #3).
- Combining probabilistic and deterministic approaches to earthquake hazard and design-basis development is most appropriate and is representative of the current state of art (App. E, DOE comment #3).

NEED FOR THIS STP

- Staff site characterization analysis identified significant concerns on DOE's plans to investigate fault displacement and Seismic Hazards
- While NRC has no objection to DOE starting site characterization, no significant progress has been made in resolving staff concerns in this area
- Site characterization has begun at Yucca Mountain
- Staff position on the level of conservatism in fault displacement and seismic hazard investigations formally described by this STP.

APPROACH ADOPTED IN THIS STP

- Benefits from past regulatory experience in using explicit criteria for identifying fault and seismic hazards
- Outline data necessary to fulfill requirements of 10 CFR 60
- Use deterministic criteria to determine which faults require detailed investigation
- Permit the removal of criteria from further consideration for the identification of faults subject to displacement if data are inconclusive (with appropriate documentation)
- Identify the entire Quaternary record as the period of geologic time that should be considered
- Allow for reconsideration of faults eliminated from further consideration if assumptions change.
- Recognizes the need to perform iterative assessments of performance and that additional investigations to those noted in the STP may be identified by these assessments.

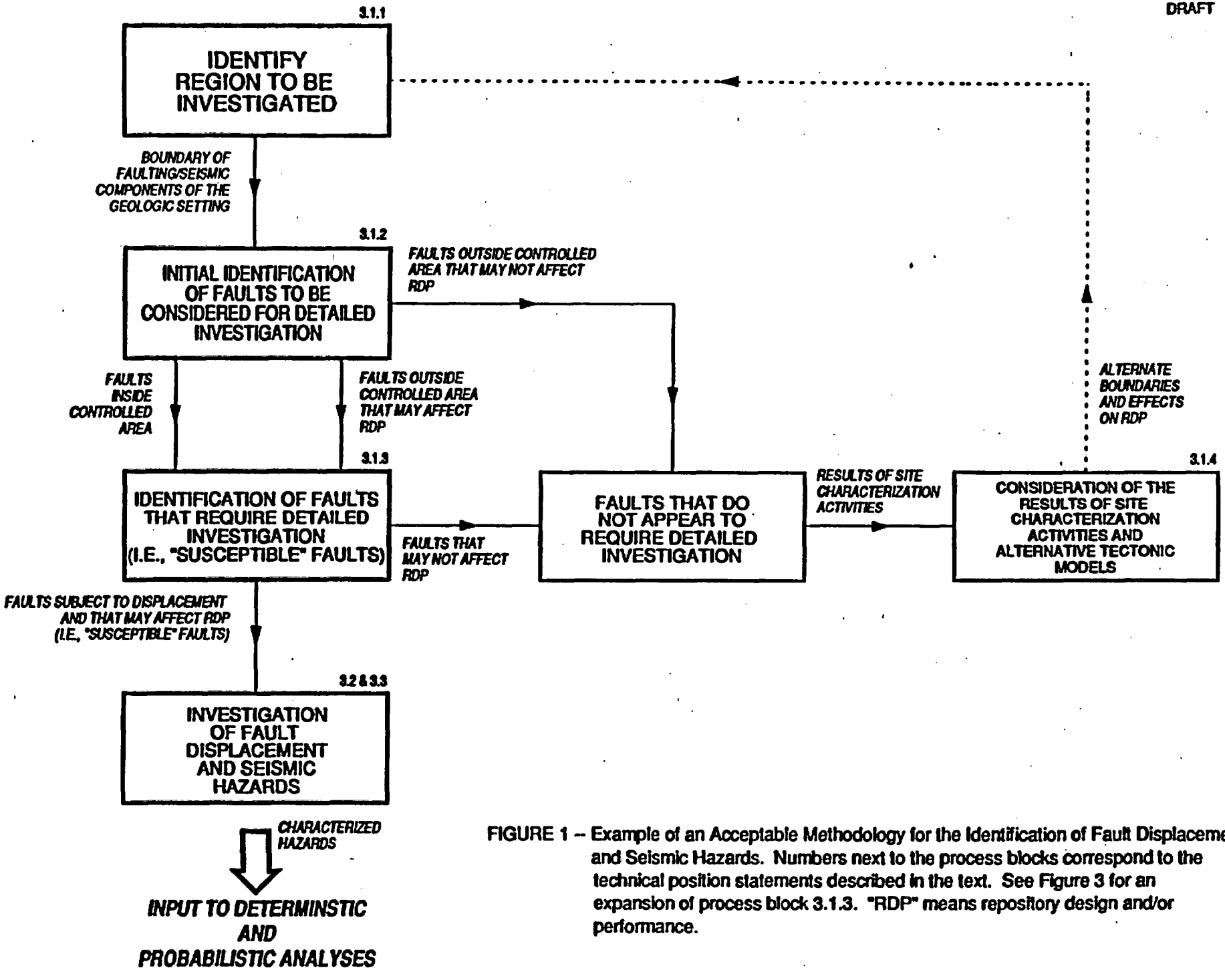

FIGURE 1 -- Example of an Acceptable Methodology for the Identification of Fault Displacement and Seismic Hazards. Numbers next to the process blocks correspond to the technical position statements described in the text. See Figure 3 for an expansion of process block 3.1.3. "RDP" means repository design and/or performance.

DEFINITION OF SUSCEPTIBLE FAULT

A Susceptible fault is a fault that:

1) is subject to displacement; and

2) affects the design or performance of structures, systems, and components important to safety, containment, or waste isolation; and/or

3) will provide data for significant input to models used in assessments of design or performance of structures, systems, and components important to safety, containment, or waste isolation

DEFINITION OF "SUBJECT TO DISPLACEMENT"

- A fault is subject to displacement if:
  there is evidence of displacement during the Quaternary period;

  In those cases where the Quaternary record is incomplete or unclear, the following additional criteria should be applied:

  a) has seismicity that suggests a direct relationship with a candidate fault;
  b) has a structural relationship to a fault that meets one or more of the other criteria;
  c) is oriented such that it is subject to displacement in the existing stress field.

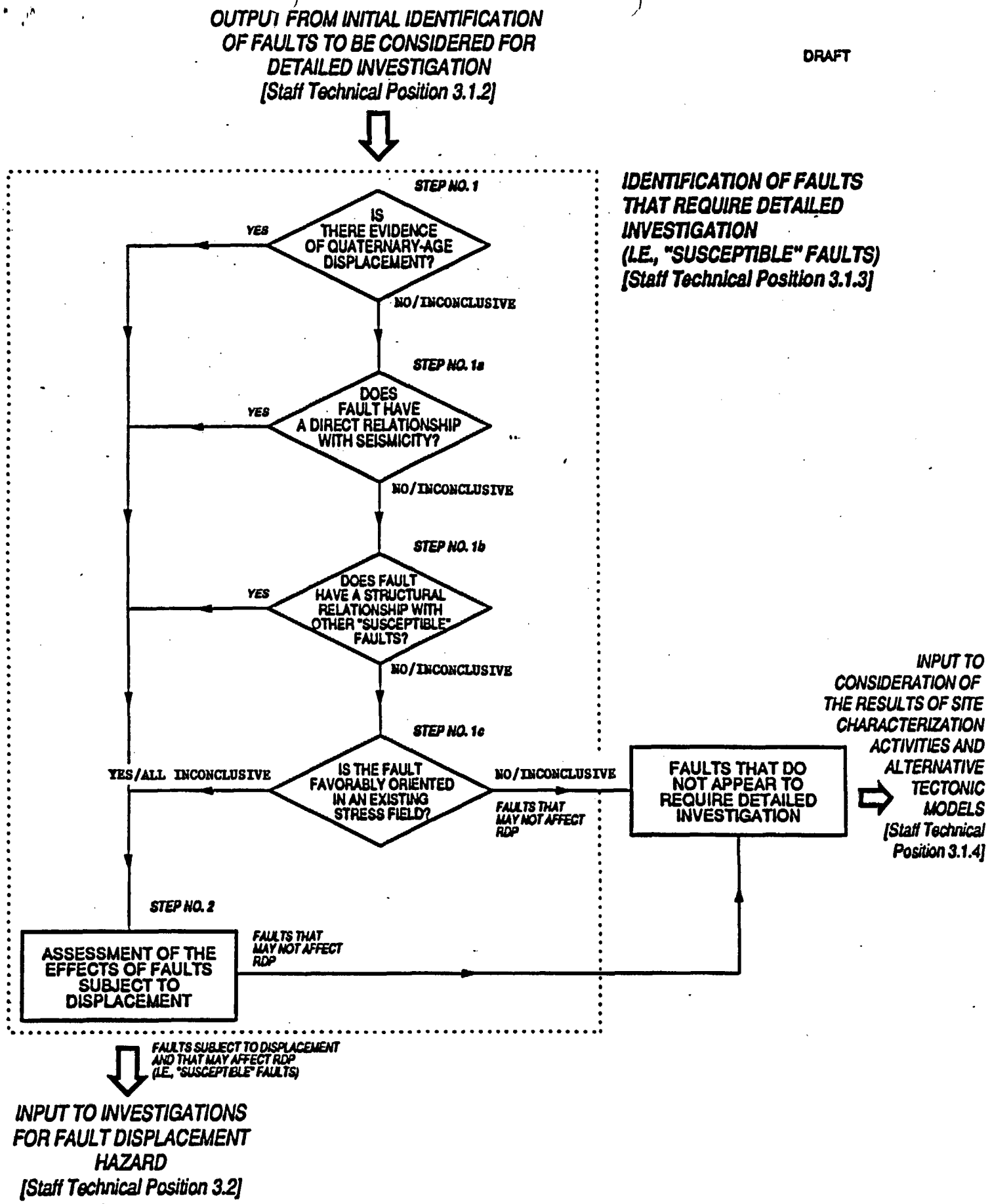

FIGURE 3 -- Staff Technical Position 3.1.3: Detail to the "Approach to the Identification of Faults that Require Detailed Investigation (i.e., "susceptible" faults)." Refer to the text for the discussion of this two-step process. Also see Figure 1. "RDP" means repository design and/or performance.

VIBRATORY GROUND MOTION INVESTIGATIONS

1. LIST ALL HISTORICALLY REPORTED SEISMIC EVENTS
   - DATES, AND EPICENTER COORDINATES
   - DEPTH, DISTANCE, AND ORIGIN TIME
   - MAGNITUDES OR HIGHEST INTENSITY
   - FOR EVENTS WITH ACCELERATION > .1G AT THE SITE, PROVIDE DURATION AND FREQUENCY CONTENT
   - SOURCE PARAMETERS (e.g., FOCAL MECHANISM, SEISMIC MOMENT, AND STRESS DROP)
   - IDENTIFY WHETHER THE EVENT IS AN EARTHQUAKE, UNE, OR CAVITY COLLAPSE

VIBRATORY GROUND MOTION INVESTIGATIONS

2. CORRELATE EARTHQUAKE EPICENTERS WITH GEOLOGICAL STRUCTURES

   - IDENTIFY METHODS AND ACCURACY USED TO LOCATE EARTHQUAKES
   - PROVIDE RATIONALE FOR THOSE WHICH CANNOT BE ASSOCIATED

3. IDENTIFY GEOLOGIC STRUCTURES SIGNIFICANT FOR EARTHQUAKE POTENTIAL

   - BURIED OR EXPRESSED AT THE SURFACE
   - INDUCED BY LOADING

VIBRATORY GROUND MOTION INVESTIGATIONS

4. IDENTIFY FAULTS IMPORTANT FOR SEISMIC DESIGN BASIS

- FAULT LENGTH
- RUPTURE LENGTH
- RUPTURE AREA
- DISPLACEMENT
- TYPE OF FAULT
- SLIP RATE

5. DETERMINE ENGINEERING PROPERTIES OF MATERIALS UNDERLYING THE SITE

- RESPONSE TO EARTHQUAKES
- SEISMIC WAVE VELOCITIES
- WATER TABLE ELEVATION
- DENSITY
- RIGIDITY
- POROSITY

VIBRATORY GROUND MOTION INVESTIGATIONS

6. DETERMINE REGIONAL ATTENUATION OF VIBRATORY GROUND MOTION

7. INVESTIGATE RELATION BETWEEN SURFACE AND SUBSURFACE GROUND MOTIONS
   - VARIATION IN HORIZONTAL AND VERTICAL ACCELERATION
   - VARIATION IN FREQUENCY CONTENT

SIGNIFICANT CHANGES TO STP IN RESPONSE TO COMMENTS

- Recognition that the process to identify fault displacement and seismic hazards may not be entirely "deterministic"
- Narrows criteria used to identify faults that require detailed investigation
- Permit the removal of criteria from further consideration for the identification of faults subject to displacement if data are inconclusive (with appropriate documentation)
- Explicitly identify the staff consideration that it is better to err on the side of identifying some matters that may ultimately be found to be unimportant
- Recognize that collection of seismicity data below that which would produce less than 0.1g at the site may be important for the postclosure period of perfomance
- Added an appendix that more explicitly states why Appendix A of 10 CFR 100 is not applicable to a high-level waste repository.