Department of Energy
Washington, DC 20585

DEC 19 1990

Mr. John J. Linehan
Director, Division of High-Level
Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Linehan:

Enclosed are responses to 16 comments made by the NRC on Site Characterization Plan (SCP) Study Plan 8.3.1.17.4.2, "Location and Recency of Faulting Near Prospective Surface Facilities." The first seven comments are contained in the Site Characterization Analysis (SCA), and a response to these have arrived under separate cover. Only those nine comments unique from those in the SCA are responded to. Revision 2 of Administrative Procedure (AP)-1.10Q (Preparation, Review, Approval, and Revision of SCP Study Plans) specifies that comments on Study Plans are handled by the process defined in AP-1.14 (Disposition of Comments on the Site Characterization Program).

Each NRC comment on this Study Plan has been given a unique identifier for tracking purposes by the Yucca Mountain Site Characterization Project Office (YMSCPO). The package was forwarded to the Sandia National Laboratories Technical Project Officer and Principal Investigator(s) for an assessment of potential impact on the planned study/activity and a recommendation for how each comment may be addressed. Based on these comments and questions, YMSCPO has determined that no changes to the Study Plan are needed.

These responses may not provide a final disposition of the NRC comments, because some comments cannot be resolved without accumulating further data from the field, or without involving additional interactions with regard to further interpretation of regulatory requirements.

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Should you have questions in this regard, please contact either Sharon Skuchko of my office on (202) 586-4590, or me on (202) 586-1462.

Sincerely,

Linda J. Desell

Linda J. Desell, Acting Chief
Regulatory Integration Branch
Office of Systems and Compliance
Office of Civilian Radioactive
Waste Management

Enclosure:
DOE Responses to NRC Comments on Study Plan 8.3.1.17.4.2, "Location and Recency of Faulting Near Prospective Surface Facilities"

cc:
R. Loux, State of Nevada
M. Baughman, Lincoln County, NV
D. Bechtel, Clark County, NV
S. Bradhurst, Nye County, NV

U.S. DEPARTMENT OF ENERGY'S COMMENT RESPONSES FOR THE COMMENTS RECEIVED FROM THE U.S. NUCLEAR REGULATORY COMMISSION ON STUDY PLAN 8.3.1.17.4.2

The U.S. Nuclear Regulatory Commission (NRC) submitted comments on the Study Plan 8.3.1.17.4.2 (Location and Recency of Faulting Near Prospective Surface Facilities) in a letter dated March 16, 1990. The U.S. Department of Energy (DOE) first renumbered the pages contained in the letter received from the NRC and identified individual comments within the letter. The comments were then enumerated from the aggregate package that was submitted; the total number of comments was 16. A copy of the enumerated comment package is provided under separate enclosure for cross reference. Each comment number is marked in the margin of the page and the page number is marked in the upper right hand corner of the page. Where multiple comments occur on one page, each is bracketed by horizontal lines.

The first seven comments identified by DOE are the same comments that the NRC submitted within the Site Characterization Analysis (SCA), which are cross-referenced to the SCA response package. For the remaining comments, the DOE response package provides a description of the comment, followed by the response. Each comment was either furnished an individual response, or cross-referenced to a response pertaining to the same overall theme.

U.S NUCLEAR REGULATORY COMMISSION COMMENTS
ON STUDY PLAN 8.3.1.17.4.2

COMMENT 1

See U.S. Department of Energy's response to the U.S. Nuclear Regulatory Commissions Site Characterization Analysis comment #48.

COMMENT 2

See U.S. Department of Energy's response to the U.S. Nuclear Regulatory Commissions Site Characterization Analysis comment #50.

COMMENT 3

See U.S. Department of Energy's response to the U.S. Nuclear Regulatory Commissions Site Characterization Analysis comment #51.

COMMENT 4

See U.S. Department of Energy's response to the U.S. Nuclear Regulatory Commissions Site Characterization Analysis comment #60.

COMMENT 5

See U.S. Department of Energy's response to the U.S. Nuclear Regulatory Commissions Site Characterization Analysis comment #62.

COMMENT 6

See U.S. Department of Energy's response to the U.S. Nuclear Regulatory Commissions Site Characterization Analysis comment #63.

COMMENT 7

See U.S. Department of Energy's response to the U.S. Nuclear Regulatory Commissions Site Characterization Analysis comment #71.

COMMENT 8:

The objective and scope of this study plan may not coincide with the overall siting goal for FITS referred to in the SCP.

BASIS:

1) The SCP suggests that the overall siting goal for FITS is that "Surface FITS will be sited where there is no evidence of substantial Quaternary faulting" (p. 8.3.1.17-61).

2) The study plan indicates that "a considerable effort will be placed on identifying an area for the waste-handling buildings where no Quaternary faults have occurred" (p. 32).

3) The objective of this study plan is to identify areas where "late Quaternary faults" are absent (p. i).

4) It appears from the statement cited above that the broader concern in locating a suitable site for FITS is to identify areas that do not contain any Quaternary faults. The identification of areas where "late Quaternary faults" are absent may not coincide with the overall siting goal.

RECOMMENDATION:

1) The objective and scope of the study plan need to coincide with the overall siting goal for surface facilities so that the data necessary for licensing will be collected.

RESPONSE

A primary concern of the comment appears to hinge on the usage of Quaternary and late Quaternary, both in the study plan and in the Site Characterization Plan (SCP). The SCP sets a minimum goal for this study to expose strata that are at least 100,000 years old. It is expected that significantly older Quaternary strata would be investigated because confidence in interpreting more recent geologic history would increase as geologically older deposits are studied. Activity 8.3.1.17.4.2.1 (Identify Appropriate Trench Locations in Midway Valley) is designated to select locations that would substantially exceed the minimum goal. However, it is unlikely that the trenches in this study will be able to expose deposits that cover the full span of the Quaternary Period within Midway Valley. The Quaternary/Tertiary contact is beneath realistic trenching depths in much of the valley. Therefore, the term "Later Quaternary" was used in the study plan to indicate a time period of approximately the past 100,000 years, which is of the greatest interest for assessing the potential for surface faulting at the surface facilities during the preclosure period.

As a sidelight, the comment is correct in that there are some apparent differences between objectives and scope of Studies 8.3.1.17.4.2 (Location and Recency of Faulting Near Prospective Surface Facilities) and 8.3.1.17.2.1, (Faulting Potential at the Repository), that may not have been completely discussed in the SCP or Study Plan 8.3.1.17.4.2. In estimating the hazard posed by faulting at the surface facility location during the preclosure period, Study 8.3.1.17.2.1 would consider all available information on

faulting (or the absence of faulting) in the vicinity of the site during the Quaternary. The evaluation would consider the trenching results from Study 8.3.1.17.4.2 as well as the data from geophysical, drilling, and faulting investigations that are part of other SCP Studies. All of these data sources would have limitations in supplying information (some or all will not cover the full span of the Quaternary Period) and in their sensitivity in detecting faults or demonstrating the continuity of strata. One of the principal tasks for this study would be the evaluation of limitations and making sure that these limitations are adequately represented in the final analyses.

REFERENCE

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.17.4.2, Location and Recency of Faulting Near Prospective Surface Facilities, Yucca Mountain Project Office, Las Vegas, NV.

COMMENT 9:

It is not apparent how the planned activities meet the stated purpose of the study plan.

BASIS:

1) The study plan indicates that this study will "evaluate the location and recency of faulting near prospective surface facilities in Midway Valley" (p. 1).

2) On p. 8, the plan indicates that the study will document the existence of "any faults within and adjacent to the candidate area proposed for the waste-handling buildings."

3) On p. 23, the plan indicates that the area of the study plan was chosen so that a preliminary assessment of the structural and stratigraphic characteristics of the surficial deposits and underlying bedrock in any candidate areas can be completed (emphasis added).

4) On p. 32, the plan states that, "...a considerable effort will be placed on identifying an area for the waste-handling buildings where no Quaternary faults have occurred."

5) On p. 33, the plan indicates that this study will be more detailed than similar studies (assumed to be referring to study 8.3.1.17.4.6) and may be useful for creating models for Quaternary faults at Yucca Mountain.

However,

6) The abstract to the study plan stated that, "The objective of this study is strictly to gather geologic data from Midway Valley and to identify areas where late Quaternary faults are absent." This statement implies that areas that may contain Quaternary faults, but not later Quaternary faults, are unimportant to fulfilling the purpose of the study plan.

7) On p. 23, the study plan indicates that long trenches will be sited in areas "where late Quaternary faults are absent or, if present ..." suggesting that fault evaluation studies are to be sited in areas where faults are believed to be absent and hence will not be used to characterize faults in Midway Valley.

8) The emphasis of the study will be on determining the existence of only those faults that are considered "significant late Quaternary faults" (p. 5). No plans are outlined in this study for addressing faults that may be Quaternary in age and do not offset sediments younger than 100,000 years.

9) The study plan indicates (p. 5) under the "Objectives" that "If late Quaternary faults are found, they will be characterized" implying that only faults that are judged to be "late Quaternary" faults will be characterized.

10) On p. 32, the plan indicates that, "a considerable effort will be placed on identifying an area ... where no Quaternary faults have occurred" implying that characterizing areas in Midway Valley that may contain Quaternary faults is of secondary importance in this study.

RECOMMENDATION:

1) Reconcile the limited scope and objectives of activities in this study plan with the much broader purpose of the study.

RESPONSE

The U.S. Department of Energy finds no contradiction in the statements referenced in the comment when they are considered in the context of the Site Characterization Plan (SCP). Because one of the objectives of this and related studies is to evaluate the hazard posed by surface faulting, the study is designed to determine whether there is evidence for surface faulting in the geologically recent past at the proposed building locations. The primary focus of this study is to provide detailed site specific data with respect to the potential for surface faulting at the site for the surface facilities. A viable approach for defining an acceptable building site is to identify an area where it can be demonstrated with a high degree of confidence that there is an absence of faults and/or that the faults, if present, are sufficiently old that they do not pose a significant surface faulting hazard during the period of concern (approximately the next 100 years).

If, during the course of the study, the trenching investigation encounters a fault, that fault would be characterized so that valuable information will not be lost. However, the primary goal of the study is not to find and characterize faults. the primary goal is to locate and characterize an area where Quaternary faulting can be demonstrated to be absent. During Activity 8.3.1.17.4.2.1 (Identify Appropriate Trench Locations in Midway Valley) there could be some overlap with other SCP studies, because features that might indicate faulting in the Midway Valley area would have to be identified in order to select sites without evidence of faulting for the main trenching studies in Activity 8.3.1.17.4.2.2 (Conduct Exploratory Trenching in Midway Valley). The relationship between the limited scope of work for Study 8.3.1.17.4.2 and other SCP studies that are designed to investigate the history of Quaternary faulting in the Yucca Mountain area is presented in the SCP.

REFERENCE

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.17.4.2, Location and Recency of Faulting Near Prospective Surface Facilities, Yucca Mountain Project Office, Las Vegas, NV.

COMMENT 10:

Faults trending approximately N-S receive the major consideration in the study plan. However, other possible fault orientations such as east-west trending strike-slip faults may be present in Midway Valley.

BASIS:

1) Although the general trend of most faults identified in the vicinity is approximately north-south (Section 1.4, p. 13), some of the apparent structural offsets and truncations of such north-south trending features may be the result of strike-slip faults (SCP Section 1.3.2.2.2).

2) Strike-slip faulting, possibly contemporaneous with faulting on the north-south faults (SCP Section 1.3.2.2.2), could be responsible for the degree of segmentation of the north-south faults.

3) Fault segmentation is an important factor in evaluating the seismic hazard (Schwartz and Coppersmith, 1986).

RECOMMENDATION:

1) Activity 1 tasks should specifically take into account the possibility of faults with other orientations than approximately N-S.

REFERENCE:

Schwartz, D.P., and Coppersmith, K.J., 1986, Seismic hazards: New trends in analysis using geologic data; in Wallace, R.E., ed., Active Tectonics, National Academy Press, Studies in Geophysics.

RESPONSE

Activity 8.3.1.17.4.2.1 (Identify Appropriate Trench Locations in Midway Valley) consists of a remote sensing analysis of the Midway Valley area that is supplemented by field checking, short trenches or test pits, and possibly some shallow geophysical investigations. The activity would consider all potential evidence of faulting (e.g., lineaments), irrespective of their orientation in selecting sites for the investigations in Activity 8.3.1.17.4.2.2 (Conduct Exploratory Trenching in Midway Valley). Activity 8.3.1.17.4.2.1 does take into account the possibility of faults having orientations other than approximately north-south. See also the response to comment 14.

COMMENT 11:

The geophysical program discussed in the study plan for evaluating the location and recency of faulting in Midway Valley may need clarification. Without knowing what reliance is placed on geophysical methods to evaluate location and recency of faulting, the adequacy of such methods/tests cannot be determined.

BASIS:

1) On p. 21, the study plan states "Various geophysical and remote sensing techniques (Table 2-1), useful for evaluating subsurface geology, may be considered for this study (emphasis added). Thus, it is not clear which of these geophysical techniques will be considered in the investigation and if any will be utilized.

2) Under the description of Activities 1 and 2 on p. 36 and 41, it is mentioned that geophysical surveys will be conducted, but no mention is made in figure 3-1 which of these surveys will be carried out other than remote sensing, and at which stage in the activity this will be performed.

3) Results of previous geophysical investigations have not been discussed.

RECOMMENDATION:

1) Provide a more clearly defined geophysical program for adequate characterization of the location and recency of faulting at the site, with the locations and resolutions of each survey.

RESPONSE

The types of geophysical surveys that would be considered for Activity 8.3.1.17.4.2.1 (Identify Appropriate Trench Locations in Midway Valley) are listed in Table 2-1. The geophysical surveys that have been conducted in the Yucca Mountain area are summarized in Oliver et al. (1990). The results of all previous geophysical investigations in Midway Valley are being evaluated as part of the data compilation and review portion of Activity 8.3.1.17.4.2.1 (Identify Appropriate Trench Locations in Midway Valley). Based on the review of these data and an assessment of recent developments in shallow geophysical exploration methods, if additional geophysical surveys are warranted, feasibility experiments would be performed to evaluate their potential for imaging shallow strata (i.e. , penetration depths of less than about 100m). One purpose of these surveys would be to determine if well-stratified units of suitable age (e.g., >100,000 yr.) are present at depths that can be reached during the trenching program. A second purpose of the surveys would be to gather additional information on lineaments or other potential fault-related features that may be identified during Activity 8.3.1.17.4.2.1. This information would also be used in selecting potential locations for the facilities important to safety (FITS) and long trenches during Activity 8.3.1.17.4.2.2 (Conduct Exploratory Trenching in Midway Valley).

Geophysical surveys to investigate deeper features of interest, such as the contact between the valley fill and bedrock, are not a primary emphasis of

this study. These types of surveys would be conducted in other studies (e.g., 8.3.1.14.2.1 (Exploratory Program) and 8.3.1.17.4.7 (Subsurface Geometry and Concealed Extensions of Quaternary Faults at Yucca Mountain))

REFERENCE

Oliver, H.W., Hardin, E.L., and Nelson, P.H., 1990. Status of Data, Major Results, and Plans for Geophysical Activities, Yucca Mountain Project, Las Vegas, NV.

COMMENT 12:

The studies outlined in table 1-4 may not provide the spectrum of information necessary to make judgments about design requirements of FITS.

BASIS:

1) Table 1-4 (p. 9) lists the studies that will provide information for site characterization of Midway Valley. Omitted from table 1-4 and possibly from consideration of faulting at Midway Valley are the results of Study 8.3.1.17.4.4 on Northeast-trending faults, Study 8.3.1.17.4.5 on detachment faulting, Study 8.3.1.17.4.8 on the stress field at the site, and Study 8.3.1.17.4.12 on tectonic models.

RECOMMENDATION:

1) Consider incorporating the results of other activities into the site characterization effort of Midway Valley.

RESPONSE

The studies listed in Table 1-4 were judged to be the ones that would be the prime contributors to the selection of FITS and in providing information to characterize the surface faulting hazard so that the design engineers can determine design requirements. Other studies, such as those listed in the comment, may also provide information. They were not listed in the table because it was believed that they were unlikely to provide location-specific information that could be used in selecting potential FITS locations. As mentioned in the response to comment 8, Study 8.3.1.17.2.1 (Faulting Potential at the Repository) would review all pertinent information from Investigation 8.3.1.17.4 (Preclosure Tectonics Data Collection and Analysis) and other relevant investigations in making its summary assessment of the surface faulting hazard at a location for prospective FITS.

COMMENT 13:

How activities outlined in this study plan interface with Activity 8.3.1.17.4.6.2 may need clarification. The descriptions seem to indicate either duplication or that the Midway Valley study is a subset of study plan 8.3.1.17.4.6.2.

BASIS:

1) Activity 8.3.1.17.4.6.2 proposes to "Determine, through trenching and mapping, the location, spatial orientation, length, ...of ... suspected or possible Quaternary faults within the site area."

2) Activity 8.3.1.17.4.2.2 proposes to "evaluate the location and recency of faulting near prospective surface facilities in Midway Valley."

3) The study plan is unclear on which study will investigate the possible presence of faults with significant early Quaternary movement in Midway Valley near the site of the surface facilities.

RECOMMENDATION:

1) The study plan should illustrate the relationship between Activities 8.3.1.17.4.2.2 and 8.3.1.17.4.6.2 so as to demonstrate that Quaternary faults, if they exist in Midway Valley in the vicinity of FITS, will be adequately characterized.

RESPONSE

The relationship between the type of data to be gathered by studies 8.3.1.17.4.2 ad 8.3.1.17.4.6 is stated in the Site Characterization Plan. Although studies 8.3.1.17.4.2 (Location and Recency of Faulting Near Repository Surface Facilities) and 8.3.1.17.4.6 (Quaternary Faulting Within the Site Area) are related, there is little or no intentional duplication in the scope of work for these studies. The primary purpose of both studies is to provide data and analysis that are required by Investigation 8.3.1.17.2 (Studies to Provide Required Information on Fault Displacement that could affect Repository Design and Performance). As such, Study 8.3.1.17.4.2 is largely a data gathering task. It is designed to characterize a specific location for FITS. The primary goal of Investigation 8.3.1.17.2 is to identify a location for surface facilities where it can be demonstrated with a high degree of confidence that there is an absence of Quaternary faulting in the shallow subsurface beneath the FITS (see also the responses to Comments 8 and 9), which includes the Midway Valley Area. It is obvious that the information collected on fault characteristics would be very important in the analyses of the potential for surface faulting at the location for FITS. Integration of the results obtained from studies 8.3.1.17.4.2 and 8.3.1.17.4.6 would be accomplished in Study 8.3.1.17.2.1 (Faulting Potential at the Repository). Careful coordination between studies 8.3.1.17.4.2 and 8.3.1.17.4.6 is necessary to avoid unnecessary duplication of surfaces to constrain the timing of faulting (or absence of faulting) is an activity that is common to both these studies. In Study 8.3.1.17.4.2 a Technical Overview

Panel that includes individuals from both of the organizations conducting these studies has been established to facilitate coordination and to avoid any unnecessary duplication of effort.

REFERENCE

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.17.4.2, Location and Recency of Faulting Near Prospective Surface Facilities, Yucca Mountain Project Office, Las Vegas, NV.

COMMENT 14:

The study plan statement that focal mechanism solutions for recent microearthquakes in the vicinity of Yucca Mountain indicate strike-slip motion on faults trending approximately N-S (page 13) tends to downplay the possibility that there could be strike-slip motion on faults trending approximately east-west as well.

BASIS:

1) Focal mechanism solutions such as those illustrated in SCP Figure 1-61 identify two mutually perpendicular planes, one of which is presumed to be the fault plane where the earthquake dislocation occurred; the second plane, sometimes called the auxiliary plane, divides space into regions of either compressional or dilatational initial seismic wave motion.

2) Most of the focal mechanism solutions illustrated in SCP Figure 1-61 are less than magnitude 2.0 with the largest being only magnitude 2.6; these microearthquakes involve very small dislocation areas with radii of a few tens to a little more than one hundred meters at most.

3) No correlation has been established between these microearthquakes and particular faults and, given the size of these microearthquakes and small areal extent of the rupture, a number of alternative fault models could account for the pattern of focal mechanisms.

RECOMMENDATIONS:

1) Until there exists evidence sufficient to support one or the other of the planes determined in a focal mechanism solution as the fault plane, both should be considered as potential fault planes.

2) The study plan should not overlook the possibility that east-west trending faults may exist in Midway Valley. Thus N-S trenches and/or geophysical surveys should be considered for inclusion in the study plan.

RESPONSE

The main objective of this study is to determine whether evidence for surface faulting exists at prospective FITS locations. The U.S. Department of Energy recognizes the importance of identifying and characterizing faults of all possible orientations. As discussed in the Site Characterization Plan (page 8.3.1.17-96) and in the Study Plan (p. 42), the detailed field investigations at prospective FITS locations are being designed to detect faults of any orientation in the Midway Valley area.

COMMENT 15:

The study plan's treatment of tectonic characteristics of the Yucca Mountain region may result in an overly optimistic projection of faulting in the area.

BASIS:

1) The study plan states that, "Yucca Mountain is located within a zone of northerly trending, high-angle normal faults..." However, the Yucca Mountain region also contains numerous northeast, northwest, and possibly north-trending strike-slip faults some of which may have Quaternary offset (e.g., Stagecoach Road fault) (SCP p. 8.3.1.17-132).

2) Scott and Bonk's (1984) cross section depicts the Midway Valley fault zone as having the same orientation and a similar amount of offset Tertiary units and fault width as the Bow Ridge fault suggesting the presence of a major block-bounding fault beneath Midway Valley. Neal and Carr (1987) indicate the Midway Valley fault has several hundred meters of displacement. The implications of having a fault of this magnitude under Midway Valley are not discussed.

RECOMMENDATION:

1) The study plan should consider the structural complexity of the Yucca Mountain region to assure that investigations will tend not to underestimate the effects of faulting on FITS.

REFERENCES:

Neal, J.T., and Carr, W.J., 1987, Characterization of geologic structure for placement of repository surface facilities, Yucca Mountain, NV: Geological Society of America Abstracts with Programs, V. 19, no. 6, p. 436.

Scott, R.B., and Bonk, J., 1984, Preliminary geologic map of Yucca Mountain Nye County, Nevada, with geologic sections: U.S. Geological Survey Open-File Report, 84-494, Scale 1:12,000.

RESPONSE

The recognition of the possibility of surface faulting under any prospective FITS location in Midway Valley is implicit in the Study Plan. The Site Characterization Plan establishes a group of studies aimed at addressing the issue of surface faulting. These studies are required since presently available information does not allow the identification, with a sufficient level of confidence, of all faults in Midway Valley that could pose a hazard to FITS if surface rupture occurred. Therefore, it is important to determine the probability that surface faulting may occur at the prospective FITS location. Study 8.3.1.17.4.2 (Location and Recency of Faulting Near Prospective Surface Facilities) provides some of the required information for this evaluation by determining whether there is any evidence of surface faulting during the Quaternary period within Midway Valley. Other studies would provide information on the presence and nature of faults in the Tertiary rocks beneath the alluvial valley fill and information on the relationships of faults at the bedrock-valley fill contact.

REFERENCE

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.17.4.2, Location and Recency of Faulting Near Prospective Surface Facilities, Yucca Mountain Project Office, Las Vegas, NV.

COMMENT 16:

Recent reports indicated that the confidence placed in radiometric age determinations for providing evidence of the age of the most recent fault movement may need re-evaluation.

BASIS:

1) The study plan provides a detailed description of the use of uranium-trend and uranium-series techniques in dating movements on faults in the Midway Valley area, stating that the uranium-series method is "a widely accepted technique with a well-defined theoretical basis" and that the uranium-trend method is "very effective in the types of materials expected to be found in Midway Valley."

2) Use of these dating techniques led Swadley and others (1984) to conclude that the age of movement on the Windy Wash fault was between 40 Ka and 1.2 Ma. Whitney and others (1986) have demonstrated that the ages for faulting used by Swadley and others (1984) are incorrect and have presented evidence suggesting Holocene movement on the Windy Wash fault. Holocene movement on the Windy Wash fault is supported by recent statement by Los Alamos investigators who have indicated that the volcanic ash in the Windy Wash fault is probably related to the 20 Ka cone at Lathrop Wells. These new ages of movement for the Windy Wash fault cast doubt on ages derived for faulting through the uranium-series and uranium-trend dating techniques.

3) The study plan indicates that techniques likely to be used for establishing numerical ages for the Quaternary deposits may have errors of several tens of thousands of years. However, Rosholt and others (1985) report that uranium-trend ages for unit Q2c range from 270 ± 50 Ka to 444 ± 60 Ka and indicate that these ages are consistent with other age determinations. Rosholt and others (1985) also report that younger gravels in unit Q2c contain reworked cinders from the Big Dune basalt center (i.e., Lathrop Wells cone) which have K-Ar ages ranging from 230 Ka to 300 Ka. More recent investigations at Lathrop Wells have discredited the K-Ar ages for the Lathrop Wells cone (Crowe and others, 1988) indicating that the cinder cone at Lathrop Wells is substantially younger than 300 Ka and casting doubt on the assumed age of unit Q2c and the uranium-trend ages. Therefore, the rock dating techniques may have substantially grater errors than recognized in the study plan.

RECOMMENDATION:

1) The study plan should discuss and consider more thoroughly the uncertainties of the available rock dating techniques and the implications those uncertainties may have on the ability to resolve faulting concerns.

REFERENCES:

Crowe, B., Harrington, C., McFaddin, L., Perry, F., Wells, S., Turrin, B., and Champion, D., 1988, Preliminary geologic map of the Lathrop Wells volcanic center: Los Alamos National Laboratory, LA-UR-88-4155. 7 p.

Rosholt, J.N., Bush, C.A., Carr, W.J., Hoover, D.L., Swadley, W.C., and Dooley, J.R., Jr., 1985, Uranium-trend dating of Quaternary deposits in the Nevada Test Site area, Nevada and California: U.S. Geological Survey Open-File Report 85-540.

Swadley, W.C., Hoover, D.L., and Rosholt, J.N., 1984, Preliminary report on late Cenozoic faulting and stratigraphy in the vicinity of Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-788, 42 p.

Whitney, J.W., Shroba, R.R., Simonds, F.W., and Harding, S.T., 1986, Recurrent Quaternary movement on the Windy Wash fault, Nye County, Nevada: Geological Society of America Abstracts with Program, v. 18, p. 787.

RESPONSE

Quaternary dating techniques are subject to uncertainty from a variety of sources. The analytical error reported by the dating laboratory may not completely describe (or limit) these uncertainties. Compilation and review of reported age dates and the available dating techniques relevant to dating deposits of Quaternary age, such as soils and geomorphic surfaces in Midway Valley, is an important part of this study. To assess the degree of uncertainty involved in age determinations of strata exposed in the Midway Valley trenches, multiple analyses would be used wherever possible. First, multiple samples from the same horizon would be dated using the same technique. Second, multiple techniques (as feasible) would be used to date a single horizon. An analysis of the results from this testing program should provide an indication of the uncertainties related to the dating of strata in the trenches.

Site Characterization Analysis Comments
Applicable to Study Plan 8.3.1.17.4.2
Evaluating the Location and Recency of
Faulting Near Prospective Surface Facilities.

Comment Number	Page	Category Assigned	Relevant Comments	Comment Description
1	3	G,FLT	SCA 48,	Use of fault slip rates on the repository facilities are not conservative.
2	5	G,FLT	SCA 50	Faults are considered single strands of narrow width.
3	7	G,GPHYS	SCA 51	Adequacy of geophysics in evaluating basaltic volcanism.
4	8	G	SCA 60	Adequacy of Preclosure design and performance goals and characterization parameters.
5	11	G,T,SF	SCA 62	Use of standoff distance in preclosure tectonics for surface facilities.
6	13	G,T,SF	SCA 63	Use of pre-existing and unavailable information for the preclosure tectonics program and the surface facilities.
7	15	ENG,G,FLT	SCA 71	Adequacy of technologies in assessing faulting for construction, operation and closure.
8	16	SF		Overall siting goal for surface facilities needs to coincide with study plan 8.3.1.17.4.2 .
9	17	SP		Objectives and activities in study plan 8.3.1.17.4.2 need to reconciled to have a much broader purpose of the study.
10	19	G,FLT		Activity 1 should account for faults with other orientations than approximately N-S.

* SCA = Site Characterization Analysis (NRC comments on the SCP)

ENCLOSURE 2

Comment Number	Page	Category Assigned	Relevant Comments	Comment Description
11	20	GPHYS,FLT		Need a more clearly defined geophysical program of faulting at the site.
12	21	SP		Incorporate the results of other activities into the site characterization effort of Midway Valley.
13	22	SP		Interface activities within the study plan.
14	23	G,FLT		Study plan should not overlook the possibility east-west trending faults at Midway Valley.
15	24	G,T		Consider structural complexity of the Yucca Mountain region to assure that the effects of faulting on FITS will not be underestimated.
16	25	G,RADIO,FLT		Uncertainties of the available rock dating techniques and the implications of theses uncertainties to resolve faulting concerns should be discussed.

* SCA = Site Characterization Analysis (NRC comments on the SCP)
NRC = Nuclear Regulatory Commission Point Papers (NRC comments on the SCPCD)

NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 16 1990

Mr. Ralph Stein, Associate Director
for Systems Integration and Regulations
Office of Civilian Radioactive Waste Management
U.S. Department of Energy, RW-30
Washington, D.C. 20545

Dear Mr. Stein:

In my letter to you dated November 24, 1989, I informed you that the NRC staff had found the study plan "Evaluating the Location and Recency of Faulting Near Prospective Surface Facilities" (Study Plan 8.3.1.17.4.2) acceptable for further review, and in addition, that the NRC staff's Start-Work Review of that study plan had identified no objections with the activities proposed. I also indicated that the NRC had decided to proceed with a Detailed Technical Review of that study plan. The purpose of this letter is to transmit the results of the NRC staff's Detailed Technical Review.

The NRC staff has two general concerns relative to the study plan. The first is that the characterization parameters and related data requirements that form the basis for the fault investigations in this study are questionable and have not been sufficiently justified in either the Site Characterization Plan (SCP) or in this study plan. These parameters and data requirements are the subject of several comments in the NRC staff Site Characterization Analysis (SCA) of the SCP (Enclosure 1 contains the pertinent comments). This study plan was reviewed specifically for whether the increased level of detail available in the study plan satisfactorily addressed the SCA comments. The staff concluded that those SCA comments were not addressed in the study plan. Hence the staff is concerned as to whether the study plan will obtain appropriate data for licensing, and specifically, for siting surface facilities important to safety (FITS).

The staff's second general concern is that even if the parameters and data requirements can be justified, the approach laid out in this study plan may not obtain the information for siting FITS that it is intended to obtain. In reaching this conclusion, the staff viewed this study in concert with related studies proposed in the SCP. The overall siting goal in the SCP for surface facilities is to place them in an area where there is no evidence of substantial Quaternary faulting. This study, even when viewed in the context of related studies, does not appear to assure that all Quaternary faults in Midway Valley with potential impact on FITS are to be sought and investigated. Enclosure 2 contains the staff's comments relating to this general concern with the study plan.

The detailed technical review comments on this study plan (Enclosure 2) will be tracked by the NRC staff as open items similar to SCA objections, comments, and questions. NRC recommends timely resolution of these comments and is prepared to interact with DOE upon DOE's request to work toward resolution.

ENCLOSURE 1

9122 4 PP

9004320057 1 2pp.

If you have any questions concerning this letter or the enclosures, please contact King Stablein (FTS 492-0446) of my staff.

Sincerely,

John J. Linehan, Director
Repository Licensing and Quality
Assurance Project Directorate
Division of High-Level Waste Management

Enclosures: As stated

cc: R. Loux, State of Nevada
C. Gertz, DOE/NV
S. Bradhurst, Nye County, NV
M. Baughman, Lincoln County, NV
D. Bechtel, Clark County, NV
D. Weigel, GAO

SITE CHARACTERIZATION ANALYSIS (SCA) COMMENTS APPLICABLE TO THE STUDY PLAN FOR EVALUATING THE LOCATION AND RECENCY OF FAULTING NEAR PROSPECTIVE SURFACE FACILITIES (8.3.1.17.4.2)

SCA COMMENT 48

The use of fault slip rates to determine the level of hazard posed to repository facilities by faults does not appear to be a conservative approach and may result in overly optimistic predictions about the effects of faulting on system performance.

BASIS

1) The concern expressed by this comment reiterates and expands on CDSCP Comment 37.

2) In the response to CDSCP comment 37, the DOE indicates that the "goals established for performance measures properly distinguish between faults within and outside the waste emplacement area, take into account for present uncertainties in slip rates and appear to be readily achievable."

1 3) The NRC staff does not consider that the approach for distinguishing similarly oriented faults in the geologic setting based on their location is a reasonably conservative approach because it appears to overlook alternative models of faulting that could physically link faults with higher apparent slip rates with faults with lower apparent slip rates.

4) Section 8.3.1.8 (p. 8.3.1.8-27) indicates that since faults in the area of the repository have "very low slip rates" then it can be demonstrated that offset of 5 cm in 1,000 years is a very low probability. Therefore, 5 cm was determined as a value at which displacement becomes significant over a 1,000 year period.

5) Slip rates average offset along faults over a series of events and appear to obscure the episodicity of fault events and relatively high offsets that could be expected in single event. For example, the last major episode of movement (Holocene in age) on one strand of the Windy Wash fault zone (slip rate estimated to be .0015mm/yr, p. 1-133) had approximately 10 cm of vertical offset.

6) The use of slip-rates is likely to obscure the uncertainty in the total offset on a fault due strike-slip motion.

7) The statement made in 8.3.1.8 (p. 8.3.1.8-27) that faults in the area have "very low slip rates" suggests that fault characteristics have been pre-judged prior to the completion of site characterization. However, the SCP acknowledges that the lateral component on most faults in the area has not been assessed.

RECOMMENDATIONS

1 Demonstrate that the use of slip rates for determining hazard does not provide overly optimistic predictions of the effects of faulting on repository performance.

Consider alternative methods (e.g., maximum event offset) or a combination of methods (e.g., maximum event offset and slip rates) to assess the level of hazard to the surface facilities and EBS posed by faulting.

SCA COMMENT 50

Faults appear to be considered as single strands of narrow width, an approach that may underestimate the effects of faulting on the results of planned tests and on the performance of repository facilities.

BASIS

1) Table 8.3.1.8-2b indicates that the current estimate of the width of Quaternary fault zones in and near the site is < 5 m.

2) Chapter 1 (p. 1-332) indicates that "Breccia zones in the Ghost Dance fault are as wide as 20 m." Cross-section A-A' of Scott and Bonk (1984), indicates that the breccia zone associated with the Solitario Canyon fault zone, the Windy Wash fault zone, and the Bow Ridge fault zone are all significantly greater than 5 m.

3) Table 8.3.1.8-2b indicates that the characterization parameter for investigating faults in the repository is characteristics of faults with > 10 m
2 of offset. Individual fault strands within a fault zone may not exhibit > 10 m of offset but the cumulative offset along faults in a fault zone may be greater than 10 m.

4) Table 8.3.1.17-3b indicates that the current estimate for "potentially significant faults" within 5 km of facilities important to safety (FITS) is four. This estimate appears to overlook models involving fault imbrication in which major fault zones might contain more than one "potentially significant fault."

5) One model resulting from seismic studies in Midway Valley (Neal, 1986) could suggest that in the vicinity of the location of the surface facilities, the Paintbrush Canyon fault zone could represent a zone of imbricate faulting extending from the east side of Exile Hill to the main trace of the Paintbrush Canyon fault.

RECOMMENDATION

The approach to characterization of faults in the vicinity of repository facilities should consider alternative models of faulting in which faults are not independent entities but may be parts of larger fault zones.

REFERENCES

Neal, J.T., 1986, Preliminary validation of geology at site for repository surface facilities, Yucca Mountain, Nevada: Sandia National Laboratories, Sand85-0815, 27 p.

2 Scott, R.B., and Bonk, J., 1984. Preliminary geologic map of Yucca Mountain Nye County, Nevada, with geologic sections: U.S. Geological Survey Open-File Report, 84-494, Scale 1:12,000.

SCA COMMENT 51

Geophysical survey programs as indicated in the SCP may not be sufficient to identify and characterize both the deep crustal and shallow geologic features and their interrelationship.

BASIS

1) In response to CDSCP comment 49, a new activity of integration was added in section 8.3.1.4.1.2. Since the subject of the CDSCP comment 49 was the insufficiency of geophysical coverage to characterize the Yucca site and the geologic setting, a response that only addresses integration of geophysical activities is not sufficient.

2) A single long refraction line as noted in Figure 8.3.1.4.6 is generally
3 inconclusive and/or no definition of an anomalous trend is possible. With a single line of investigation as planned, there is a significantly increased probability that ambiguous data and/or incorrect interpretations will occur.

3) Most of the proposed geophysical activities such as shown in Figure 8.3.1.4.7 (seismic reflection) and Figure 8.3.1.4.8 (gravity and magnetic) indicate coverage that is isolated and not crossed or tied to other lines.

RECOMMENDATIONS

1) Provide a geophysical investigation program plan that is comprehensive, integrated and sufficient to identify and understand the interrelationships of the deep crustal structure and shallow geologic structural features, and to assure that no significant structural features have gone undetected.

2) Consider including a gridded program of exploratory surveys and measurements that would allow for cross-line correlations and more complete spatial definition of anomalies at the site and specifically at the locations of the exploratory shafts.

SCA COMMENT 60

The NRC staff does not consider that the basis and rationale for the design and performance parameters, characterization parameters, and goals proposed in the SCP for fault displacement, in particular for fault investigations for facilities important to safety (FITS), have been justified. The staff is concerned as these values appear to be used to limit the exploration program prior to having sufficient data to evaluate the site.

BASIS

1) The concern expressed by this comment is part of the concern expressed in CDSCP Comment 50. This comment specifically is in reference to the requested justification of the design, performance, and characterization parameters.

2) In the response to CDSCP comment 50 and in the tables the DOE gives the following design and performance parameters:

> Table 8.3.1.17-3a gives design and performance parameters related to surface facilities and preclosure fault displacement as "total probability of exceeding 5 cm fault displacement at locations proposed for FITS, with a goal of less than 1 chance in 100 of exceeding 5 cm displacement beneath surface FITS in 100 years."
>
> Table 8.3.1.17-3b gives characterization parameters as "the identification and characterization of potential Quaternary faults within 5 km of FITS," "Identification and characterization of faults within 100 m of FITS that have apparent Quaternary slip rates greater than .001 mm/yr or that measurably offset materials less than 100,000 years old," and "estimate of total probability for greater than 5 cm displacement beneath FITs, considering known and possible concealed faults and tectonic interrelationships among local faults."

3) The NRC does not consider that DOE has presented a justifiable basis for the use of 100,000 years as a base age to determine if the offset is significant. The basis for most information within 10 CFR Part 60 is the Quaternary, and other similar nuclear facilities such as those licensed under 10 CFR 72 have used Appendix A criteria for determining the significance of fault activity (i.e., once in 35,000 years or more than once in 500,000 years).

4) The DOE has presented no analysis of the proposed design to demonstrate that 5 cm of fault movement is acceptable. The DOE appears to assume that structures can be built to withstand that amount of movement, however, the staff has seen no analysis to support this assumption.

5) The NRC also does not consider that the probability cut off values on the parameters and goals which are being used to limit the investigation, such as 1 chance in 100 in 100 years, have been justified. The NRC staff does not agree with the attempted justification presented in the response to CDSCP comment 50 because:

The use of the probability cut off has not been accepted for use in determining the items on the Q-List (see Comment 126), and The work of Reiter and Jackson (1983) was not intended as guidance for making a licensing decision, but rather to evaluate the relative safety of existing plants. In addition, the authors themselves state that no great confidence can be placed on the absolute probabilities.

6) The SCP discusses "potentially significant faults," however, the NRC staff is unsure as to what is meant by this term. It appears that DOE intends this to be related to the above probability values, age of movement or limit of movement; however, as stated above, the NRC staff does not see justification for the values. Until site characterization is complete, the interrelationship of faults is known, the interrelationship of the site parameters to the design parameters has been established, and the potential effect of the various faults on meeting the various performance objectives has been determined, the staff cannot determine what faults are significant (see also Comment 64).

7) The SCP states on page 8.3.1.17-27 that probabilistic methods will be used for evaluating the adequacy of deterministic final results; however, the
4 question of what investigations will be conducted appears to be controlled by a priori probabilistic assumptions. For example, the response to CDSCP comment 50 states that the total probability of faulting will be assessed prior to trenching. The NRC staff is unsure how DOE intends to assign probability values related to various features prior to completing the site characterization program. If the characterization program is overly limited by a priori probability assumptions, the NRC staff is unsure how a sufficient understanding of the site characteristics will ever be obtained.

8) While the NRC staff recognizes that "goals" are not "criteria," when goals are set which do not appear to be justified, or which appear to unwisely limit the necessary investigations, the NRC staff does not see a rationale for the investigation which can be supported.

RECOMMENDATION

DOE needs to strengthen its justification for the design and performance parameters, characterization parameters, and goals for preclosure fault displacement as related to FITS, or revise these values. The justification should include a discussion of the interrelationship of the characterization parameters, performance and design parameters, and goals with the design criteria and the performance objectives of 10 CFR Part 60.

REFERENCES

Reiter, L., and Jackson, R.E., 1983, Seismic Hazard Review for the Systematic Evaluation Program - A Use of Probability in Decision Making: NUREG-0967, U.S. Nuclear Regulatory Commission.

4 U.S. Department of Energy, Letter from S. Rousso, DOE, to H. Thomoson, Jr., NRC; Subject: Issuance of the Site Characterization Plan (SCP) for the Yucca Mountain Site to the U.S. Nuclear Regulatory Commission, December 28, 1988, 4pp. plus 3 enclosures, including "Responses to NRC Point Papers on Site Characterization Plan/Consultation Draft."

SCA COMMENT 62

The information presented for the program of investigations for study of faulting at the surface facilities does not allow the NRC staff to determine how DOE is proposing to use standoff distances in designing the program of investigations and in performing the resultant design and analysis.

BASIS

1) The concern expressed by this comment is a continuation of the concern expressed in CDSCP Comment 50 regarding standoff distance from faults.

2) The SCP states on page 8.3.1.17-96 "Note that the 100 meter distance is not intended to represent an appropriate standoff distance for FITS from faults that have a potential for displacement. Should the faulting investigations identify a fault within 100 meters of the proposed FITS locations, the appropriate standoff distance and/or mitigative engineering measures will be assessed."

3) The NRC staff is unsure what DOE is proposing for appropriate stand off distances. The statement in the SCP seems to suggest that the DOE considers less than 100m as an appropriate standoff distance for faults which have a potential for displacement. The NRC has seen no justification for such a position.

4) The DOE response to CDSCP comment 50 states that trenches will likely be excavated beyond 100 meters past FITS, but does not state that trenches will be excavated past 100 meters. The NRC, therefore, is not sure what is the extent of trenching which is planned, and how faults greater than 100 meters from FITS will be investigated or evaluated.

5) 10 CFR Part 60.122(a) requires that DOE demonstrate, among others, that:

> (i) potentially adverse conditions have been adequately investigated, including the extent to which the condition may be present and still be undetected;
>
> (ii) potentially adverse conditions be adequately evaluated using analyses which are not likely to underestimate its effect; and
>
> (iii) the condition will not significantly affect the ability of the site to meet the performance objectives, can be compensated for, or can be remedied.

6) While 10 CFR 60.122 is directed at postclosure concerns, the information used in the evaluation of FITS will be used to help evaluate the postclosure conditions, and the basic principles laid out within 10 CFR 60.122(a) will apply to all phases of the licensing process. The program laid out for evaluation of faulting near or at FITS appears to be ignoring these principles.

RECOMMENDATION

The DOE needs to demonstrate that:

(i) the program of investigations for faulting at or near FITS will adequately evaluate all faults which have a potential of movement, and/or

(ii) that the evaluation of the effects of faulting, taking into account the degree of resolution of the investigation, will not underestimate the effects, and

(iii) the effect of faulting will not compromise the ability of the FITS to meet the performance objectives

REFERENCE

Neal, James T., 1986, Preliminary Validation of Geology at site for Repository Surface Facilities, Yucca Mountain Nevada: Sandia National Laboratories, SAND85-0815.

SCA COMMENT 63

The information presented for the program of investigations for study of faulting at the surface facilities does not appear to have integrated pre-existing information and makes assumptions about pre-existing information and ongoing investigations which the NRC cannot evaluate because the NRC has not seen the background information.

BASIS

1) The concern expressed by this comment is a continuation of the concern raised by the response to CDSCP Comment 50.

2) SCP Section 8.3.1.17.4.2 suggests that possible locations for trenching will be based on air photo interpretation, geologic mapping and possible use of geophysical investigations. Geologic mapping and geophysical investigations have been conducted in the area of the proposed surface facility and suggest the presence of many closely spaced normal faults and a high degree of fracturing in the subsurface (Neal, 1986). The NRC staff is unsure as to how
6 this information has and/or will be used to plan additional trenching, mapping, and geophysical investigations in the area of the surface facilities. Neal (1986) appears to identify many areas which have questionable geologic structure; however, there appear to be no present plans to investigate these areas.

3) This work is being planned to be used in licensing; however, the NRC staff is unsure as to how much of the preexisting information is planned to be qualified, can be qualified under the Quality Assurance program, or the potential effect on schedules if some of the planned information cannot be qualified (see also Comment 126). Much of the work which forms the basis for many of the assumptions within this section has been ongoing and is considered by DOE to be substantially complete. For example, mapping of trenches on the Bow Ridge fault system is considered to be 50% complete (SCP page 8.3.1.17-160), a Quaternary-fault map has been published and mapping of surfical geologic deposits is considered to be 25% complete (SCP page 8.3.1.17-156). The NRC has not seen any official results from the investigations.

RECOMMENDATION

Prior to the NRC staff being able to evaluate the program of site investigations, the DOE needs to complete at least the planning step of integration of the site program. This should include not only a separate integration of drilling, or a separate integration of geophysics, but a complete integration of the planned program of investigations. This integration should show how ongoing activities and pre-existing information has been incorporated into the program, and should demonstrate what assumptions are being made on the qualification of pre-existing data.

REFERENCE

6 Neal, James T., 1986, Preliminary Validation of Geology at site for Repository Surface Facilities, Yucca Mountain Nevada: Sandia National Laboratories, SAND85-0815.

SCA Comment 71 P. 5

The tentative goal, design parameter, and expected value relating faulting (e.g., "significant Quaternary fault") and performance allocation for System Element 1.1.2 are not sufficient for adequately characterizing the hazard posed by faulting.

Basis:

1) The concern expressed by this comment is part of the concern expressed by CDSCP Comment 62.

2) The response to CDSCP comment 62 revises the performance measure and eliminates the term "potentially active fault." However, a new term, "significant Quaternary fault," is introduced. The definition of the term "significant Quaternary fault" implies that only faults with demonstrable Quaternary offset represent a hazard to the repository in the preclosure and that the magnitude of offset along faults that may contain a significant component of lateral movement (i.e., strike-slip) can be accurately determined. Due to the potential for large uncertainties associated with both of these
7 assumptions, use of this term "significant Quaternary fault" does not appear to be reasonably conservative approach to address preclosure tectonics issues.

3) The design parameter indicates that "significant Quaternary faults" will be identified and characterized; however, the NRC staff continues to be concerned (Comment 35) that the site characterization program is inadequate to characterize potentially adverse conditions in the southern part of the repository block.

4) The expected value for "significant Quaternary faults" indicates that none are expected to be found. This value does not consider alternative models for faulting in the geologic setting or the implication from Figs. 8.4.2-4 and 8.3.1.4-10 that an imbricate fault zone may occur in the waste emplacement area.

RECOMMENDATIONS

Consideration should be given to using alternative fault models as a conceptual basis for assessing the preclosure hazard to the repository.

Demonstrate that from a scientific perspective, the program of drifting in the northern part of the repository combined with the systematic drilling program and feature sampling program will provide the information necessary to ensure that conditions and processes encountered are representative of conditions and processes throughout the site and that potentially adverse conditions will be adequately investigated.

DETAILED TECHNICAL REVIEW COMMENTS ON THE STUDY PLAN FOR EVALUATING THE LOCATION AND RECENCY OF FAULTING NEAR PROSPECTIVE SURFACE FACILITIES (8.3.1.17.4.2)

Comment 1

The objective and scope of this study plan may not coincide with the overall siting goal for FITS referred to in the SCP.

Basis:

1) The SCP suggests that the overall siting goal for FITS is that "Surface FITS will be sited where there is no evidence of substantial Quaternary faulting" (p. 8.3.1.17-61).

8 2) The study plan indicates that "a considerable effort will be placed on identifying an area for the waste-handling buildings where no Quaternary faults have occurred" (p. 32).

3) The objective of this study plan is to identify areas where "late Quaternary faults" are absent (p. 1).

4) It appears from the statement cited above, that the broader concern in locating a suitable site for FIT is to identify areas that do not contain any Quaternary faults. The identification of areas where "late Quaternary faults" are absent may not coincide with the overall siting goal.

Recommendation:

1) The objective and scope of the study plan need to coincide with the overall siting goal for surface facilities so that the data necessary for licensing will be collected.

Comment 2

It is not apparent how the planned activities meet the stated purpose of the study plan.

Basis:

1) The study plan indicates that this study will "evaluate the location and recency of faulting near prospective surface facilities in Midway Valley" (p. 1).

2) On p. 8, the plan indicates that the study will document the existence of "any faults within and adjacent to the candidate area proposed for the waste-handling buildings."

3) On p. 23, the plan indicates that the area of the study plan was chosen so that a preliminary assessment of the structural and stratigraphic characteristics of the surficial deposits and underlying bedrock in any candidate areas can be completed (emphasis added).

9

4) On p. 32, the plan states that, "...a considerable effort will be placed on identifying an area for the waste-handling buildings where no Quaternary faults have occurred."

5) On p. 33, the plan indicates that this study will be more detailed than similar studies (assumed to be referring to study 8.3.1.17.4.6) and may be useful for creating models for Quaternary faults at Yucca Mountain.

However,

6) The abstract to the study plan states that, "The objective of this study is strictly to gather geologic data from Midway Valley and to identify areas where late Quaternary faults are absent." This statement implies that areas that may contain Quaternary faults, but not late Quaternary faults, are unimportant to fulfilling the purpose of the study plan.

7) On p. 23, the study plan indicates that long trenches will be sited in areas "where late Quaternary faults are absent or, if present ..." suggesting that fault evaluation studies are to be sited in areas where faults are believed to be absent and hence will not be used to characterize faults in Midway Valley.

8) The emphasis of the study will be on determining the existence of only those faults that are considered "significant late Quaternary faults" (p. 5). No plans are outlined in this study for addressing faults that may be Quaternary in age and do not offset sediments younger than 100,000 years.

9) The study plan indicates (p. 5) under the "Objectives" that "If late Quaternary faults are found, they will be characterized" implying that only faults that are judged to be "late Quaternary" faults will be characterized.

10) On p. 32, the plan indicates that, "a considerable effort will be placed on identifying an area ... where no Quaternary faults have occurred" implying that
9 characterizing areas in Midway Valley that may contain Quaternary faults is of secondary importance in this study.

Recommendation:

1) Reconcile the limited scope and objectives of activities in this study plan with the much broader purpose of the study.

COMMENT 3

Faults trending approximately N-S receive the major consideration in the study plan. However, other possible fault orientations such as east-west trending strike-slip faults may be present in Midway Valley.

Basis:

1) Although the general trend of most faults identified in the vicinity is approximately north-south (Section 1.4, p. 13), some of the apparent structural offsets and truncations of such north-south trending features may be the result of strike-slip faults (SCP Section 1.3.2.2.2).

2) Strike-slip faulting, possibly contemporaneous with faulting on the north-south faults (SCP Section 1.3.2.2.2), could be responsible for the degree of segmentation of the north-south faults.

3) Fault segmentation is an important factor in evaluating the seismic hazard (Schwartz and Coppersmith, 1986).

Recommendation:

1) Activity 1 tasks should specifically take into account the possibility of faults with other orientations than approximately N-S.

Reference:

Schwartz, D.P., and Coppersmith, K.J., 1986, Seismic hazards: New trends in analysis using geologic data; in Wallace, R.E., ed., Active Tectonics, National Academy Press, Studies in Geophysics.

COMMENT 4

The geophysical program discussed in the study plan for evaluating the location and recency of faulting in Midway Valley may need clarification. Without knowing what reliance is placed on geophysical methods to evaluate location and recency of faulting, the adequacy of such methods/tests cannot be determined.

Basis:

11 1) On p. 21, the study plan states "Various geophysical and remote sensing techniques (Table 2-1), useful for evaluating subsurface geology, may be considered for this study" [emphasis added]. Thus, it is not clear which of these geophysical techniques will be considered in the investigation and if any will be utilized.

2) Under the description of Activities 1 and 2 on p. 36 and 41, it is mentioned that geophysical surveys will be conducted, but no mention is made in figure 3-1 which of these surveys will be carried out other than remote sensing, and at which stage in the activity this will be performed.

3) Results of previous geophysical investigations have not been discussed.

Recommendation:

1) Provide a more clearly defined geophysical program for adequate characterization of the location and recency of faulting at the site, with the locations and resolutions of each survey.

Comment 5

The studies outlined in table 1-4 may not provide the spectrum of information necessary to make judgements about design requirements of FITS.

Basis:

1) Table 1-4 (p. 9) lists the studies that will provide information for site
12 characterization of Midway Valley. Omitted from table 1-4 and possibly from consideration of faulting at Midway Valley are the results of Study 8.3.1.17.4.4 on Northeast-trending faults, Study 8.3.1.17.4.5 on detachment faulting, Study 8.3.1.17.4.8 on the stress field at the site, and Study 8.3.1.17.4.12 on tectonic models.

Recommendation:

1) Consider incorporating the results of other activities into the site characterization effort of Midway Valley.

Comment 5

How activities outlined in this study plan interface with Activity 8.3.1.17.4.6.2 may need clarification. The descriptions seem to indicate either duplication or that the Midway Valley study is a subset of study plan 8.3.1.17.4.6.2.

Basis:

1) Activity 8.3.1.17.4.6.2 proposes to "Determine, through trenching and
13 mapping, the location, spatial orientation, length, ... of... suspected or possible Quaternary faults within the site area."

2) Activity 8.3.1.17.4.2.2 proposes to "evaluate the location and recency of faulting near prospective surface facilities in Midway Valley."

3) The study plan is unclear on which study will investigate the possible presence of faults with significant early Quaternary movement in Midway Valley near the site of the surface facilities.

Recommendation:

1) The study plan should illustrate the relationship between Activities 8.3.1.17.4.2.2 and 8.3.1.17.4.6.2 so as to demonstrate that Quaternary faults, if they exist in Midway Valley in the vicinity of FITS, will be adequately characterized.

COMMENT 7

The study plan statement that focal mechanism solutions for recent microearthquakes in the vicinity of Yucca Mountain indicate strike-slip motion on faults trending approximately N-S (page 13) tends to downplay the possibility that there could be strike-slip motion on faults trending approximately east-west as well.

Basis:

1) Focal mechanism solutions such as those illustrated in SCP Figure 1-61 identify two mutually perpendicular planes, one of which is presumed to be the
14 fault plane where the earthquake dislocation occurred; the second plane, sometimes called the auxiliary plane, divides space into regions of either compressional or dilatational initial seismic wave motion.

2) Most of the focal mechanism solutions illustrated in SCP Figure 1-61 are less than magnitude 2.0 with the largest being only magnitude 2.6; these microearthquakes involve very small dislocation areas with radii of a few tens to a little more than one hundred meters at most.

3) No correlation has been established between these microearthquakes and particular faults and, given the size of these microearthquakes and small areal extent of the rupture, a number of alternative fault models could account for the pattern of focal mechanisms.

Recommendations:

1) Until there exists evidence sufficient to support one or the other of the planes determined in a focal mechanism solution as the fault plane, both should be considered as potential fault planes.

2) The study plan should not overlook the possibility that east-west trending faults may exist in Midway Valley. Thus N-S trenches and/or geophysical surveys should be considered for inclusion in the study plan.

Comment 8

The study plan's treatment of tectonic characteristics of the Yucca Mountain region may result in an overly optimistic projection of faulting in the area.

Basis:

1) The study plan states that, "Yucca Mountain is located within a zone of northerly trending, high-angle normal faults..." However, the Yucca Mountain region also contains numerous northeast, northwest, and possibly north-trending strike-slip faults some of which may have Quaternary offset (e.g., Stagecoach Road fault) (SCP p.8.3.1.17-132).

2) Scott and Bonk's (1984) cross section depicts the Midway Valley fault zone as having the same orientation and a similar amount of offset Tertiary units and fault width as the Bow Ridge fault suggesting the presence of a major block-bounding fault beneath Midway Valley. Neal and Carr (1987) indicate the
15 Midway Valley fault has several hundred meters of displacement. The implications of having a fault of this magnitude under Midway Valley are not discussed.

Recommendation:

1) The study plan should consider the structural complexity of the Yucca Mountain region to assure that investigations will tend not to underestimate the effects of faulting on FITS.

References:

Neal, J.T., and Carr, W.J., 1987, Characterization of geologic structure for placement of repository surface facilities, Yucca Mountain, NV: Geological Society of America Abstracts with Programs, v. 19, no. 6, p. 436.

Scott, R.B., and Bonk, J., 1984, Preliminary geologic map of Yucca Mountain Nye County, Nevada, with geologic sections: U.S. Geological Survey Open-File Report, 84-494, Scale 1:12,000.

Comment 9

Recent reports indicated that the confidence placed in radiometric age determinations for providing evidence of the age of the most recent fault movement may need reevaluation.

Basis:

1) The study plan provides a detailed description of the use of uranium-trend and uranium-series techniques in dating movements on faults in the Midway Valley area, stating that the uranium-series method is "a widely accepted technique with a well-defined theoretical basis" and that the uranium-trend method is "very effective in the types of materials expected to be found in Midway Valley."

2) Use of these dating techniques led Swadley and others (1984) to conclude that the age of movement on the Windy Wash fault was between 40 Ka and 1.2 Ma.
16 Whitney and others (1986) have demonstrated that the ages for faulting used by Swadley and others (1984) are incorrect and have presented evidence suggesting Holocene movement on the Windy Wash fault. Holocene movement on the Windy Wash fault is supported by recent statements by Los Alamos investigators who have indicated that the volcanic ash in the Windy Wash fault is probably related to the 20 Ka cone at Lathrop Wells. These new ages of movement for the Windy Wash fault cast doubt on ages derived for faulting through the uranium-series and uranium-trend dating techniques.

3) The study plan indicates that techniques likely to be used for establishing numerical ages for the Quaternary deposits may have errors of several tens of thousands of years. However, Rosholt and others (1985) report that uranium-trend ages for unit Q2c range from 270 ± 50 Ka to 444 ± 60 Ka and indicate that these ages are consistent with other age determinations. Rosholt and others (1985) also report that younger gravels in unit Q2c contain reworked cinders from the Big Dune basalt center (i.e., Lathrop Wells cone) which have K-Ar ages ranging from 230 Ka to 300 Ka. More recent investigations at Lathrop Wells have discredited the K-Ar ages for the Lathrop Wells cone (Crowe and others, 1988) indicating that the cinder cone at Lathrop Wells is substantially younger than 300 Ka and casting doubt on the assumed age of unit Q2c and the uranium-trend ages. Therefore, the rock dating techniques may have substantially greater errors than recognized in the study plan.

Recommendation:

1) The study plan should discuss and consider more thoroughly the uncertainties of the available rock dating techniques and the implications those uncertainties may have on the ability to resolve faulting concerns.

References:

Crowe, B., Harrington, C., McFaddin, L., Perry, F., Wells, S., Turrin, B., and Champion, D., 1988, Preliminary geologic map of the Lathrop Wells volcanic center: Los Alamos National Laboratory, LA-UR-88-4155. 7 p.

Rosholt, J.N., Bush, C.A., Carr, W.J., Hoover, D.L., Swadley, W.C., and Dooley, J.R., Jr., 1985, Uranium-trend dating of Quaternary deposits in the Nevada Test Site area, Nevada and California: U.S. Geological Survey Open-File Report 85-540.

Swadley, W.C., Hoover, D.L., and Rosholt, J.N., 1984, Preliminary report on late Cenozoic faulting and stratigraphy in the vicinity of Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-788, 42 p.

Whitney, J.W., Shroba, R.R., Simonds, F.W., and Harding, S.T., 1986, Recurrent Quaternary movement on the Windy Wash fault, Nye County, Nevada: Geological Society of America Abstracts with Program, v. 18, p. 787.