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# **Evaluation of DOE Responses to NRC Site Characterization Analysis**

**Prepared for the Nuclear Regulatory Commission  
Contract No. NRC-02-88-005  
Account No. 20-3702-021**

**RDCO Intermediate Milestone No. 20-3702-021-010-000**

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**April 16, 1991**

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## OBJECTION 1

The exploratory shaft facility (ESF) is intended to become an integral part of the repository if the site is found acceptable. However, the SCP and its references do not demonstrate the adequacy of ESF Title I design control process, and the adequacy of the ESF Title I design which is the basis for the SCP. For example, neither the design nor the subsequent Design Acceptability Analysis (DAA) considers some of the applicable 10 CFR 60 requirements. Also, decisions regarding shaft location appears to have overlooked evidence of a potential fault near the location of exploratory shafts. In addition, it has not been demonstrated that the underground test facility and currently identified test durations will permit all tests to be conducted for the time periods required without interference. Furthermore, resolution of the problems identified with the Title I design may result in considerable corresponding modifications to the SCP.

## EVALUATION OF DOE RESPONSE

- In response to this objection, DOE stated that it is conducting three studies: (1) Exploratory Shaft Facilities (ESF) Alternatives; (2) Testing Prioritization Task; and (3) Calico Hills Risk/Benefit Analysis (CHRBA). DOE expects that these studies will address some of the issues given in the objection. The staff finds that insufficient detail is provided in DOE's response to evaluate the extent to which these studies will resolve the issues.
- Discussion on ESF design related issues was not given in the DOE's response. These issues, such as how the results of the studies will be incorporated in ESF design or how ESF design will proceed, are the major concerns of this objection. DOE's only comment concerning design is that the ESF Alternative Study "evaluation" would be completed prior to the start of Title II (design).
- Progress toward closure of this objection will involve NRC review and evaluation of DOE's studies and ESF design, participation in DOE/NRC interactions, and further communication on all aspects related to this topic.
- DOE did not propose a closure of this objection in its response. The staff considers that this objection remains open.

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**COMMENT 4**

The rationale provided for the specification of information needs does not appear to ensure completeness of those needs. Furthermore, the integration of testing with design and performance assessment is lacking.

**EVALUATION OF DOE RESPONSE**

- DOE's response defers several answers to future work:
  - "Future Site Characterization Progress Report will summarize the results of additional parametric sensitivity studies and any resulting changes to the goals and confidence levels in the geoen지니어ing parameters..."
  - "...the need for expansion of Table 8.3.1.15-1 to incorporate additional data requirements...will be evaluated, and changes will be made as necessary."
- The DOE states that "the two examples cited as incomplete plans in the closure are two of the types of data to be gathered as part of the characterization of normal stiffness of joints." The intent of the NRC staff comment was to draw attention to the fact that these parameters are not included with the list of parameters in SCP Section 8.3.1.15.1.4. Progress toward closure of this concern probably will require review of Technical Procedure TP-052.
- The DOE states that "The effects of heat on design verification would be examined as part of Study 8.3.1.15.1.6. The objectives of 8.3.1.15.1.6 include that "Some of the data will be used for testing computer codes used in heat transfer and thermo-mechanical calculations." While this statement indicates an intent to make progress in the direction of model verification it falls well short of a commitment to a full-fledged design verification.
- Contrary to the statement in the DOE response that Study 8.3.1.15.1.8. includes investigations of the effects of temperature on radon release, no such investigation is explicitly mentioned in Study 8.3.1.15.1.8.
- Progress toward closure of Comment 4 will require review of SCP progress reports and of supporting documents such as study plans and technical procedures.
- The staff considers this comment open.

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**COMMENT 33**

Engineering rock parameters are not adequately integrated in the plan to develop the three-dimensional rock characteristics model.

**EVALUATION OF DOE RESPONSE**

- In response to this comment, DOE indicates that Study Plan 8.3.1.4.3.1 (Systematic Acquisition of Site-Specific Subsurface Information) contains a list of parameters that are specifically intended to be "engineering properties" and data such as "rock-unit lateral and vertical variability" and "rock unit mineralogy and petrology" would be integrated by Study 8.3.1.4.2.3 (Three Dimensional Geologic Model).
- DOE's response does not specifically address how discontinuity (i.e. fractures and faults) geometry and properties will be incorporated in the three-dimensional geologic model or more appropriately the three-dimensional rock characteristics model.
- Progress toward closure of this comment could be made by reviewing the above-mentioned study plans to see whether discussions are included on how rock unit geometry and properties, discontinuity geometry and properties, geologic framework, and geologic model will be integrated into the "three-dimensional rock characteristics model."
- The NRC staff considers DOE's response incomplete and considers that this comment remains open.

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COMMENT 37

The SCP (p. 8.3.1.4-65, 4th paragraph) states that "geologic mapping in the underground can aid in recognizing blast-induced fractures. . . ." It is not clear whether the techniques given for identification of blast fracturing are adequate to differentiate them from natural or stress-induced fractures.

EVALUATION OF DOE RESPONSE

- DOE's response indicates that the level of detail required to describe procedures for distinguishing blast-induced fractures from natural fractures are not appropriate for inclusion in a Study Plan and criteria for distinguishing these types of fractures would be described in a technical procedure.
- DOE's response also includes an extensive list of features that will be used to distinguish blasting-induced fractures from pre-existing natural fractures.
- DOE's response does not address the concern expressed about stress-relief fractures.
- Progress toward closure of this comment could be made (1) for DOE to provide evidence (publications, reports) demonstrating successful practical field implementation of the proposed procedures and (2) by NRC staff review of the DOE technical procedures currently in draft.
- The staff considers this comment open.

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**COMMENT 40**

The "rule of thumb" stating that the number of pairs that is acceptable for each spacing range should be at least 30, represents a lower bound for geostatistical analyses and may not ensure that parameter values can be estimated with the desired confidence. The SCP test is unclear on this topic.

**EVALUATION OF DOE RESPONSE**

- DOE agreed with this comment and has written Study Plan 8.3.1.4.3.1 (Systematic Acquisition of Site-Specific Subsurface Information) which describes the Systematic Drilling Program in more detail than was presented in the SCP. According to DOE the Study Plan details the use of geostatistics, as well as constraining factors, in addressing the issue of sampling adequacy.
- DOE's response acknowledges that in the SCP, the number of sampling pairs per variogram point reflected a two-dimensional surface sampling pattern, whereas actual sampling will be in three dimensions and therefore more complex than implied in the SCP.
- Closure of this comment should be postponed until the Study Plan 8.3.1.4.3.1 is reviewed by NRC.

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COMMENT 41

The tight clustering of sample locations SD-8 through SD-12, shown on Figure 8.3.1.4-12a, has not been justified to be an appropriate method of increasing the number of sample pairs for short distances and provides no assurance about the quality of the resulting variogram.

EVALUATION OF DOE RESPONSE

- DOE has stated that the concept of clustering drill holes outside the repository block to increase the number of sample pairs in variogram construction has been abandoned in Study Plan 8.3.1.4.3.1 (Systematic Acquisition of Site-Specific Subsurface Information).
- DOE noted that several of the "clustering" boreholes in the SCP are likely to be relocated for various reasons.
- DOE also noted that some of the original clustered boreholes were part of another activity (Activity 8.3.1.2.2.3.2, Site Vertical Borehole Studies) and were proposed for cross-hole testing of one type or another. DOE considers that this clustering of holes stands on its own merits.
- Closure of this comment will require NRC review of the referred Study Plan 8.3.1.4.3.1.

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COMMENT 54

Numerous inconsistencies exist in Chapter 8 of the SCP. Examples of some of the inconsistencies found in the geomechanical area are listed below by the sections in which they occur.

EVALUATION OF DOE RESPONSE

- DOE acknowledges that there are inconsistencies in the Site Characterization Plan and that current performance allocation measures, goals, and parameters and their logical relations can be improved. DOE will not purge ambiguities or inconsistencies in the SCP, but rather will explain variances in how the program for data acquisition and analysis, and for performance modeling evolves from discussions in the SCP.
- Based on DOE's commitment to explain variances in how the program for data acquisition and analysis, and for performance modeling evolves from discussions in the SCP, the NRC staff considers this comment resolved.

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## COMMENT 55

The discussion and/or use of statistics in this chapter is not clear. A statistical approach has been suggested to determine numbers of tests required to determine various rock properties, but the approach suggested is confusing and apparently overlooks several considerations that should be factored into such an approach. Also, needed confidences of "low," "medium," or "high" have been assigned without explaining the basis for such assignments.

## EVALUATION OF DOE RESPONSE

- DOE states that the validity of assumptions concerning the statistical basis for determination of sample size should be checked as new information (i.e. site data and results of sensitivity studies) becomes available. DOE's response therefore defers any changes in the technical bases for site characterization until new information is available.
- DOE's response does not clarify any of the specific points raised in Comment 55. The SCP is supposed to describe the methodology to be used in collecting data. If DOE waits until the data is collected to evaluate the method, several consequences may follow:
  - (1) The ability to find "surprises" in the data may be lost; and
  - (2) Data which "makes sense" will be accepted, and data which does not "make sense" will be rejected.
- DOE should present results of on-going sensitivity studies as the bases for assigning needed confidence levels.
- NRC should review DOE's results of site characterization and sensitivity studies, and DOE's evaluation of such information in assessing the validity of the statistical basis for the determination of sample size.
- The NRC staff considers that this comment remains open for two reasons. First, DOE has deferred any changes in the technical bases for site characterization until new information is available. Second, DOE's response is inadequate because it did not clarify any of the specific points raised in Comment 55.

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**COMMENT 56**

The validation of models should be a part of the overall test program. It is not clear that these aspects have been addressed by the test program.

**EVALUATION OF DOE RESPONSE**

- DOE refers to discussions of model validations presented in several places in the SCP, and specifically to SCP Section 8.3.1.15.1 for "testing related to the validation of rock-mechanics models." It recognizes that the details of the validation process are not presented in the brief descriptions of in situ tests in Section 8.3.1.15.1. Additional detail will be provided in the study plans relating to the in situ tests, as was done for the study plans for excavation investigations.
- DOE indicates that it is currently developing a general validation strategy which will be implemented through Test and Evaluation Plan (see response to Comment 1) using the present structure of study plans, augmented by procedures regarding data and model evaluation.
- DOE's response does not address any of the specific questions that form the basis of Comment 56.
- Progress toward closure of Comment 56 could be made by reviewing (1) the study plan for excavation investigations (8.3.1.15.1.5), from the point of view of Comment 56, in light of the fact that this study plan is cited in the DOE response as an example of additional detail that will help to resolve Comment 56; (2) the Study Plans relating to the in situ tests cited in the DOE's response when it becomes available; and (3) the general validation strategy, to be presented by the DOE in the Test and Evaluation Plan.
- The staff considers this comment open.

**NOTE**

DOE's response to Comment 56 references the DOE's response to Comment 1. It therefore would seem desirable to coordinate the NRC response to Comment 56 with the NRC response to Comment 1.

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COMMENT 57

Studies relating to design verification do not consider investigating the effects of underground excavation in the tuff using alternate excavation methods.

EVALUATION OF DOE RESPONSE

- DOE's response indicates that advisability and feasibility of using mechanical excavation methods are currently being investigated and that results of these ongoing investigations will be reported in Yucca Mountain Project Studies Reports (issued approximately every six months during site characterization). DOE will investigate the results of mechanical excavation methods as part of the study plan for in situ design verification, if DOE decides to excavate a portion of the ESF using mechanical means. As stated, the response does not provide a commitment to investigate mechanical excavation effects unless ESF construction includes mechanical excavation. The commitment does not seem sufficiently firm to warrant closure of Comment 57. NRC staff recognizes that a major reevaluation of ESF construction is in progress, and that the concern may become moot upon completion of the revised approach to ESF construction.
- Progress toward closure of this comment will require review of the referred Study Plan 8.3.1.15.1.8 that the study plan includes activities related to investigating the advisability and feasibility of using mechanical excavation methods as recommended by NRC.
- The NRC staff considers this comment open.

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COMMENT 58

Activity descriptions presented in the in situ Design Verification Section do not include tests to verify design aspects under repository conditions.

EVALUATION OF DOE RESPONSE

- DOE states that "The intent of the in situ design verification study is to collect and document information made available through construction of the ESF that may be useful in designing a repository at Yucca Mountain. The study is not intended to provide all the information needed for repository design." (emphasis added).
- This first part of the DOE's response seems to imply that the objective of the in situ design verification study 8.3.1.15.1.8 is to obtain information on which to base repository design, rather than to verify repository design.
- DOE's response continues with the statement that "a more detailed discussion of the purpose and rationale for this study will be provided in the Study Plan 8.3.1.15.1.8, which is in review."
- Progress toward closure of Comment 58 will depend on NRC staff review of Study Plan 8.3.1.15.1.8, particularly to identify whether the objective is to gather design information, or to verify design.
- DOE's response to the first specific item in the Basis to Comment 58 references Study 8.3.1.15.1.6, which includes among its objectives "... the deformation response of the rock around a heated room will be observed. Some of the data will be used for testing computer codes used in heat transfer and thermomechanical calculations." This commitment to analysis verification points strongly in the direction of design verification, and comes close to closing the first specific item in the Basis to Comment 58.
- The response to the second item in the Basis for Comment 58 states that "the results and effects of mechanical mining will be investigated as part of the in situ design verification, if this excavation technique is used in the ESF." As stated, the response does not provide a commitment to investigate mechanical excavation effects unless ESF construction includes mechanical excavation. The commitment does not seem sufficiently firm to warrant closure of the second specific item in the Basis for Comment 58 (see also Comment 57). NRC staff recognizes that a major reevaluation of ESF construction is in progress, and that the concern may become moot upon completion of the revised approach to ESF construction.

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- DOE's response to the third specific item in the Basis for Comment 58 references unspecified "plans." Progress toward closure of this item probably will depend upon NRC staff review of these plans.
- NRC staff considers this comment open.

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COMMENT 70

The statement in the SCP (p. 8.3.2.2-14, paragraph 3) that the blast control procedures are less important to postclosure performance has not been justified.

EVALUATION OF DOE RESPONSE

- DOE acknowledges that control of blast damage is important in underground repository facilities. DOE commits to incorporate measures to limit blast induced damage in ESF design and to investigate excavation induced damage in several ESF experiments. DOE also indicates that investigation of means for reducing blast damage (i.e. by using mechanical excavation methods) is currently underway as part of the ESF Alternative Study.
- Progress toward closure of this comment will require review of ESF design.
- Since DOE defers closure of this comment until the completion of ESF design, the NRC staff considers that this comment remains open.

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## COMMENT 72

In view of the limited data available at this time, it would be prudent for DOE to assume that seals will be needed until and unless it can be shown that seals will not be required to meet the repository performance objectives. It is not clear in the SCP that this is the assumption under which the sealing program is going to proceed.

## EVALUATION OF DOE RESPONSE

- Although the DOE "...agrees in principle with the NRC that continued sealing investigations should progress until such time as a definitive conclusion can be reached...", no commitment to follow up on the NRC recommendation is made, only a recognition that "... DOE may need to re-evaluate its seals program upon completion of the ESF Alternatives Study" (emphasis added).
- The remainder of the DOE approach outlines a broad generic strategy to be implemented as part of the ESF Alternatives Study in order "... to evaluate and identify a defensible basis for the design and construction of the ESF."
- Items 3 and 4 of the DOE's response address the specific concerns raised in the Basis of NRC Comment 72. Item 4 in particular states that the DOE will "develop new repository access configurations and ESF configuration and construction methods to address comments and concerns raised by the NRC, NWTRB, State of Nevada, and DOE."
- The latter commitment clearly outlines an approach toward closure of this comment. Final closure will have to await NRC staff review of the relevant sections of the ESF Alternative Study.
- The staff considers this comment open.

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COMMENT 73

Conservative design approach has not been used to determine required backfill hydraulic conductivity.

EVALUATION OF DOE RESPONSE

- DOE's response states that detailed design approaches for determining required backfill hydraulic conductivity are provided in SAND84-1895 and SAND85-0598 reports.
- Review of these two reports reveals that conservative nature of the approach was presented and a broad range of possible hydraulic conductivities of the rock mass from  $10^{-5}$  to  $10^{-2}$  cm/s was considered in the analysis for determination of required backfill hydraulic conductivity. DOE's response clarifies most of the NRC's concern listed as bases of Comment 73.
- DOE's response also includes some tentative commitments that may address the NRC recommendation:
  - In response to the NRC recommendation to plan and initiate in situ (sealing) tests as soon as possible, the response states that "DOE intends to obtain data on the performance of sealing components as soon as possible", leaving unanswered what the DOE intentions are with regard to in situ testing.
  - The wording of the last paragraph of the DOE's response is similarly ambiguous, and leaves it unclear as to whether or not the alternative analyses recommended in the NRC recommendation will be performed. If some alternative analyses are performed, they "... may be described in the overall performance assessment sections of these progress reports."
- Progress toward closure of this comment will depend on any future DOE plans with regard to in situ testing of seals and any future alternative inflow and outflow scenario analyses that DOE may perform.
- The staff consider this comment open.

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COMMENT 74

This section describes a four-step process to determine the need for in situ testing of seal components. However, no indication is given as to whether and when testing "to initiate in situ testing to evaluate the behavior of selected sealing components under realistic in situ conditions as well as under unlikely conditions" (p. 8.3.3.2-41) will be initiated.

EVALUATION OF DOE RESPONSE

- DOE's response indicates that testing of sealing components will be performed as part of the ESF testing. A plan indicating the nature, schedule, and the depth of testing, and a study plan dealing with field testing are in preparation.
- The DOE commits that the status of the sealing plan will be updated in Yucca Mountain Project Status Reports, issued approximately every six months during site characterization.
- Progress will be made toward resolution of the comment as the test plan and study plan become available for NRC staff review, and as Yucca Mountain Project Status Reports become available.
- The staff considers this comment open.

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COMMENT 77

In evaluating potential effects of credible accidents on projected preclosure radiological exposures, the SCP has not sufficiently considered retrieval operations.

EVALUATION OF DOE RESPONSE

- DOE's response argues that accident analyses in the SCP were performed primarily to identify structures, systems, and components that may be important to safety during repository operation and that if retrieval were required, DOE would analyze the retrieval process to identify items important to safety and measures to mitigate or prevent credible accidents. DOE also argues that it is premature to evaluate the effects of potential radiological accidents because the reasons for retrieval and the conditions under which retrieval would need to be carried out can only be speculated.
- DOE's two reasons for claiming that it is premature to evaluate the effects of potential radiological accidents are without merit. First, the reason(s) for a retrieval decision are not relevant. Second, DOE claims that it can only speculate about retrieval conditions. NRC staff agrees that retrieval conditions can not be precisely known, but consider that conditions are sufficiently known that the effects of potential radiological accidents could be evaluated.
- DOE should discuss retrieval operations in evaluating the effects of credible accidents on radiological exposures.
- The NRC staff disagrees with DOE's response and considers this comment unresolved.

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COMMENT 119

The information presented in the SCP, Section 8.3.5.16 - Performance Confirmation Testing, is insufficient to allow NRC staff to determine if the confirmation program meets the requirements of 10 CFR 60, Subpart F.

EVALUATION OF DOE RESPONSE

- DOE's response consists of two parts: a broad general response to the NRC comment, and an itemized list of responses to the itemized concerns expressed in the basis of the NRC Comment.
- The broad general response essentially defers closure of the comment to the future:
  - "Plans for the performance confirmation program have not yet been developed to the level of detail requested by the comment."
  - "More information ... are (sic) needed before the details of a program to confirm performance predictions can be settled."
  - "A strategy document to describe the procedure that will be followed to develop these details is forthcoming."
  - "Plans for the performance confirmation activities to be undertaken during repository construction and operation will be developed in two stages..."
  - "Plans for performance confirmation activities during the period following site characterization ... will be developed before the end of site characterization."
- The broad general response to Comment 119 refers to the DOE's response to Comment 118. DOE's response to Comment 118 argues, even more forcefully than the response to Comment 119, that "detailed planning for the data needs of a 10 CFR 60 Subpart F performance confirmation program ... is premature at this time."
- A significant divergence of opinions continues to exist between NRC and DOE about the level of detail and the timing of performance confirmation program.
- Progress toward closure of this divergence may be accelerated by the "meeting or technical exchange" referred to in the DOE's response to comment 118.
- Further progress toward closure of this comment will require review of the various

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plans and documents referred to in the DOE's response.

● Evaluations of the itemized DOE responses to the Basis of NRC Comment 119:

1. "The DOE position remains that a complete definition of the performance confirmation program during later repository phases is premature for the SCP and that 10 CFR Part 60 does not require a complete definition at this time." The NRC concern deals specifically and explicitly with performance confirmation which should commence during site characterization.
2. "DOE maintains that the performance confirmation program described in the SCP, and to be developed more fully as site characterization proceeds, is in accordance with the requirements of Subpart F of Part 60." Technical exchanges and/or review of the more fully developed plans will be required on resolving the opposing points of view.
3. DOE does indeed list "monitoring and testing activities identified as starting during site characterization and being used for performance confirmation." The staff considers this concern closed.
4. "DOE maintains that sufficient detail regarding near-term performance confirmation activities, namely, those that are to be started during site characterization, is being provided to allow the evaluation of their possible effects on the site." The most obvious example of a performance confirmation test for which no detail is given is the in-situ waste package testing, addressed more explicitly in Comment 118. The description of the heated room test in SCP Section 8.3.1.15.1.6.5 start with "The design of this experiment is in the preliminary stage." No specific information, e.g. with regard to room geometry, anticipated temperatures, thermal load, test duration, etc... is provided, making it difficult to understand how an evaluation of the possible impact of the test on the site could be performed. Progress toward resolution of this concern will require technical interactions or reviews of study plans, technical procedures, etc.
5. The tables referenced in the DOE's response do indeed list "tests and activities to be continued beyond site characterization." The staff considers this concern closed.
6. Whereas the NRC concern is expressed quite broadly, i.e. dealing with "... various environmental conditions ...", the DOE's response focuses narrowly on "The effect of time at elevated temperatures ..." Moreover, the DOE's response states that plans will be developed for additional testing beyond the site characterization period if results show a need for continued or longer-term

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testing. DOE's response raises a concern as to whether the investigation of the effects of variable environmental conditions on mechanical properties is as broad as stated in SCP Section 8.3.1.15.1.3.2, or is limited to thermal effects, as seems to be implied by the DOE's response. Progress toward closure of this comment will require technical exchanges, or reviews of study plans, technical procedures, etc...

- 7. DOE's response states that "The performance confirmation program as described in the SCP allows for in situ verification of the behavior of the waste package and its environment. DOE maintains that descriptions of such activities are premature at this time. More detail regarding the characteristics of the waste package and the site are needed before the particulars can be developed." Progress toward closure of this comment will require technical exchanges, or, more likely, interactions between NRC and DOE about the precise meaning of the requirements in 10 CFR Part 60 Subpart F.
- 8. DOE's response confirms that sealing testing will be initiated during ESF testing. "Development of the study plan is in progress." The flexibility to accommodate sealing tests in the ESF "... will be quantified and included as a design requirement in the ESF Systems Design Requirements Document." Closure of this comment will have to await staff review of the mentioned documents.

- The staff considers this comment open.

NOTE: Given that the DOE's response to Comment 119 refers to the DOE's response to Comment 118, it may be desirable to coordinate the NRC response to Comment 119 with the NRC response to Comment 118.

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COMMENT 121

Seismic design criteria for the ESF are not sufficiently described in the SCP.

EVALUATION OF DOE RESPONSE

- DOE's response explains why discontinuous rock deformation (which DOE calls secondary faulting) is not a credible design consideration and why it is appropriate to define the seismic design basis in terms of peak motion.
- DOE's response indicates that DOE has not understood NRC's comment. DOE apparently interprets "seismic design criteria" to be a description of the characteristics of seismic sources in terms of peak motions. NRC interprets "seismic design criteria" in a much broader sense, incorporating not only a description of the seismic source, but also allowable response of engineered structures subject to the seismic excitation.
- NRC staff disagrees with DOE's claim that if joint slip were a response to passing seismic waves that the tuff sequence would be uniformly deformed.
- DOE should expand its definition of seismic design criteria to include allowable response of engineered structures subject to seismic loading.
- The NRC staff considers DOE's response incomplete and therefore considers the comment unresolved.

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COMMENT 122

The SCP (p. 8.4.2-81) states that "a key aspect of construction control for surface-based testing, including infiltration testing, unsaturated-zone hydrology testing, and the systematic drilling program, (and multipurpose borehole drilling program) is the selection of dry coring methods. The technology for a dry coring method is yet to be proven." The SCP (page 8.4.2-86) does include a program to demonstrate the method. However, the SCP does not contain the criteria to be used to determine the acceptability of the dry coring method.

EVALUATION OF DOE RESPONSE

- DOE's response describes the advantages of dry drilling and the progress and plans for prototype dry drilling. DOE commits to addressing the issue of acceptability of the dry coring method in section 2.1 "Preparatory Activities" of the Site Characterization Progress Reports.
- Closure of this comment will require review of the Site Characterization Progress Reports regarding the issues of acceptability of the dry coring method.
- The NRC staff considers that this comment remains open.

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COMMENT 124

The discussion of the potential causes for a reduction in the drainage capacity of the shaft bottom does not include certain plausible mechanisms.

EVALUATION OF DOE RESPONSE

- DOE's response corrects statements made in NRC's bases for this comment. DOE commits to future evaluations of the environmental conditions and scenarios affecting drainage, the reporting of these evaluations in technical support documentation, and summarized if appropriate in Site Characterization Progress Reports.
- The NRC staff considers this comment resolved.

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COMMENT 128

Several applicable 10 CFR 60 requirements have not been considered in evaluation the acceptability of ESF Title I design.

EVALUATION OF DOE RESPONSE

- DOE's response explained the criteria used initially to determine whether a particular 10 CFR Part 60 requirement was applicable to the Exploratory Shaft Facility (ESF). DOE also explained its current position with regard to testing with radioactive waste (i.e. no radioactive waste would be used). DOE acknowledged that some 10 CFR Part 60 requirements could be considered to provide indirect guidance even if they didn't directly impact the ESF design. Finally DOE listed previous meetings and correspondence related to this comment and stated that the 11 requirements in question would be taken into consideration during the ESF Alternatives Study and subsequent design activities.
- DOE did not explicitly indicate how the 11 requirements in question would be considered during the ESF Alternatives Study and subsequent design activities.
- DOE did not explicitly indicate how the indirect guidance afforded by some regulations would be incorporated into ESF design activities.
- NRC should continue to track how applicable 10 CFR Part 60 requirements are addressed in DOE site characterization activities, including ESF design. In particular, NRC should review DOE's Exploratory Shaft Facility Alternatives Study as well as reports of all subsequent design activities.
- DOE has deferred closure until the ESF Alternatives Study has been submitted. The staff considers that this comment remains open.

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COMMENT 129

Various appendices of the DAA and the YMP ESF TITLE I Design Report do not consider the applicability of 10 CFR 60 requirements to the ESF Title I design in a consistent manner.

EVALUATION OF DOE RESPONSE

- DOE's response explains that the lists of applicable 10 CFR Part 60 requirements in the DAA and the YMP ESF Title I design were developed either at different times or for different purposes. DOE states that its present position on applicable requirements is given by Attachment I of the Technical Oversight Group (TOG) report.
- NRC does not agree with the list of applicable 10 CFR Part 60 requirements as given by Attachment I of the Technical Oversight Group (TOG) report. In particular, NRC considers that the requirements listed in COMMENT 128 are missing from the list of requirements given by Attachment I of the TOG report. On the basis of technical discussions at the DOE/NRC Technical Exchange: Applicability of 10 CFR Part 60 Requirements to the ESF held 18 October 1989, it's possible to estimate possible resolutions of the disagreements along the following lines.

Requirements	Applicability
60.17	applicable
60.24(a)	no resolution
60.113(a)(2)	applicable
60.113(b)(2),(3),(4)	may not be applicable
60.122	applicable
60.131(a)	no resolution
60.131(b)(4)(ii)	applicable
60.131(b)(8)	not applicable
60.131(b)(10)	applicable
60.134	applicable
60.143	may not be applicable

- DOE's response to comment 128 indicates that some of the requirements which NRC has noted as being applicable are being considered in the ESF Alternatives Study and will be considered in future studies.
- NRC should continue to track how relevant 10 CFR Part 60 requirements are

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addressed in DOE site characterization activities, including ESF design. In particular, NRC should review DOE's Exploratory Shaft Facility Alternatives Study as well as reports of all subsequent design activities.

- Because the NRC staff does not agree with the list of applicable 10 CFR Part 60 requirements given by Attachment I of the Technical Oversight Group (TOG) report, the staff considers that this comment remains open.

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COMMENT 130

Out of the fifty-two (52) 10 CFR 60 requirements considered applicable to ESF design by the DOE in reviewing the acceptability of Title I design, the DAA focuses on only 22 requirements that belong to the three areas specifically outlined by NRC. Other requirements (e.g., retrievability, preclosure radiological safety, performance confirmation, and QA program) are said to be qualitatively evaluated (see p. 2-1, second paragraph). The approach adopted in the DAA raise questions about completeness and rigor of the design acceptability analysis, as detailed design criteria were not developed for all applicable requirements.

EVALUATION OF DOE RESPONSE

- DOE's response summarizes how omission of some applicable 10 CFR Part 60 requirements were considered by the DAA. DOE commits to addressing all relevant 10 CFR Part 60 requirements in the Exploratory Shaft Facility Alternatives Study and subsequent design activities.
- DOE did not indicate criteria to be used to evaluate which 10 CFR Part 60 requirements would be considered "relevant" or how "relevant" requirements would be addressed in the Exploratory Shaft Facility Alternatives Study and subsequent design activities.
- NRC should continue to track how relevant 10 CFR Part 60 requirements are addressed in DOE site characterization activities, including ESF design. In particular, NRC should review DOE's Exploratory Shaft Facility Alternatives Study as well as reports of all subsequent design activities.
- DOE has deferred closure until the ESF Alternatives Study has been submitted. The staff considers that this comment remains open.

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COMMENT 131

One of the key steps in the DAA process was to review the adequacy of data used in Title I design. It appears that the DAA does not reasonably address this step.

EVALUATION OF DOE RESPONSE

- DOE's response addresses individually each of the four recommendations made in this comment. DOE also explains the development and purposes of the Reference Information Base (RIB) and the Site and Engineering Properties Data Base (SEPDB). The response points out that it is the designer's responsibility to evaluate, select, and justify the appropriateness of design inputs for specific uses. DOE commits to documenting and reviewing design inputs. The response also indicates that DOE expects improved interface control to ensure close compatibility between analysis goals and design needs. DOE commits to documenting use of alternate coordinate systems.
- DOE's response addresses most issues raised by this comment. However, DOE does not explain what the improved interface control process is or how it will ensure close compatibility between analysis goals and design needs.
- Closure of this comment will require review of the referred "interface control" process.
- The staff considers this comment open.

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COMMENT 132

The requirements of 10 CFR 60.21(c)(1)(ii)(D) [i.e., consideration of major design features], in particular, have not been adequately addressed in evaluating the acceptability of ESF Title I design.

EVALUATION OF DOE RESPONSE

- DOE's response describes the scope of the Exploratory Shaft Facility Alternatives Study (identified as the Exploratory Shaft Facility Alternative Configuration Study in this response). DOE indicates that an evaluation to satisfy 10 CFR 60.21(c)(1)(ii)(D) will be undertaken as part of this study. The response indicates that as part of the selection process for the preferred option a comparative evaluation of a variety of design features will be conducted. DOE indicates that the preferred option will be used as the basis for subsequent Title II design efforts.
- DOE's response does not explicitly state how the evaluation to satisfy 10 CFR 60.21(c)(1)(ii)(D) will be conducted or which design features will be considered in the evaluation.
- In a recent technical meeting between DOE and NRC (DOE/NRC Meeting on Calico Hills Risk/Benefit Analysis and ESF Alternatives Study 29-31 January 1991) DOE did not commit to using the preferred option from the Exploratory Shaft Facility Alternatives Study as the basis for Title II design.
- NRC should review DOE's Exploratory Shaft Facility Alternatives Study to assess whether 10 CFR 60.21(c)(1)(ii)(D) has been appropriately and adequately addressed. NRC should also monitor how the results of the study are incorporated in Title II design.
- DOE has deferred closure until the ESF Alternatives Study has been submitted. The staff considers that this comment remains open.

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COMMENT 133

To examine the thoroughness of the DAA, the NRC staff has reviewed the adequacy of one of the documents used in Title I design as an example. The document selected by the staff was Appendix B.4 of ESF Title I design report, "Free Field Seismic Load Calculations for ESF Drifts." This document was not reviewed by the TAR team. This appendix has errors and raises concerns as to whether the calculations were checked.

EVALUATION OF DOE RESPONSE

- DOE's response to this comment is a commitment to include Design Reviews in Title II design at multiple stages during the development of each Design Package. DOE indicates that calculations will be checked as part of these Design Reviews.
- In view of DOE's commitment to implement design review for each Design Package at multiple stages during Title II design, the staff considers this comment resolved.

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QUESTION 2

What is the current understanding of the relation between mechanical and hydraulic apertures, and how will the data from "aperture" measurements made during site characterization be used in design and performance assessment analyses?

EVALUATION OF DOE RESPONSE

- In response to the questions, DOE summarizes some of the available literature which relate mechanical and hydraulic aperture. DOE agrees with NRC that mechanical and hydraulic apertures bear an uncertain relation to each other. DOE reviews its current plans for collecting data on mechanical aperture. DOE also describes SCP Activity 8.3.1.2.2.4.1 (Intact Fracture Testing in ESF) which includes determination of mechanical deformation and fracture transmissivity on approximately 32 different fracture samples. (It was 48 samples in the SCP.) DOE noted that Activity 8.3.1.2.2.4.5 (Excavation Effects Test in the ESF) also plans to directly measure permeability changes associated with stress changes due to excavation of shafts and drifts associated with the Exploratory Shaft.
- DOE notes in the last paragraph that both experimental work and numerical modeling suggest that the hydraulic aperture may be smaller than the average physical aperture by a factor of two providing conservative estimates of the rock's capacity to isolate waste. DOE failed to point out that the same evidence would be used to argue that drainage estimates could be unconservative.
- The staff considers this question resolved because DOE is aware of the issues concerning the relation between mechanical and hydraulic aperture and relevant studies are planned in the SCP.

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QUESTION 3

What rationale was used for selecting the total area that may be needed for repository development?

EVALUATION OF DOE RESPONSE

- DOE's response is a summary of information presented in Appendix M of the SCP-CDR for estimation of the total repository area (Site Characterization Plan- Conceptual Design Report, SAND84-2641, H.R. MacDougall, L.W. Scully, and J.R. Tillerson (compilers), Albuquerque, NM, 1987). DOE commits to present results of revised area calculations in Yucca Mountain Project Status Reports.
- DOE's response does not explicitly address the issue of area needed for adequate flexibility in repository development, in planning the site characterization program. The SCP noted that 300 additional acres might be needed to ensure availability of adequate area for contingency (p.6-227). Appendix M also recommended qualifying a minimum of 300 additional acres to establish additional lateral flexibility.
- NRC should review area calculations when submitted in Yucca Mountain Project Status Reports. Area calculations should be compared to the area which DOE intends to qualify for repository development through the site characterization program.
- The NRC staff considers DOE's response incomplete and therefore considers that this question remains open.

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**QUESTION 5**

In the CDSCP (p. 8.3.1.4-91) reference was made to drilling vertical and angled exploratory boreholes. Discussion of angled holes has been removed from SCP, which raises a concern regarding the collection of representative data. What is the rationale for planning only vertical exploratory holes?

**EVALUATION OF DOE RESPONSE**

- DOE does not plan to include angled boreholes. DOE's response to this question is based on DOE's claim that their experience with core holes drilled at a maximum angle of 26 degrees does not show a noticeable increase in representativeness of a near vertical fracture system. DOE indicates that it may evaluate the need for angled boreholes on the basis of early coreholes.
- DOE's response is incomplete because it provides no reference to support the claim that core holes drilled at a maximum angle of 26 degrees do not show a noticeable increase in representativeness of a near vertical fracture system. For example, DOE does not indicate on how many holes this is based.
- It is unlikely that vertical boreholes can be used to evaluate the need for angled boreholes as claimed in the last sentence of DOE's response.
- DOE should provide evidence supporting its claim that core holes drilled at a maximum angle of 26 degrees do not show a noticeable increase in representativeness of a near vertical fracture system.
- The NRC staff considers DOE's response incomplete and therefore the question remains open.

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QUESTION 7

Why is face mapping of exploratory drifts restricted to areas where anomalous conditions are exposed?

EVALUATION OF DOE RESPONSE

- DOE has modified its original position regarding face mapping only where anomalous conditions are present. DOE agrees with the recommendation made by NRC in this question and states that shaft and drift mapping are described in Study Plan 8.3.1.4.2.2 entitled "Characterization of Structural Features in the Site Area."
- The staff considers this question resolved.

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**QUESTION 8**

What measure of predictability will accompany the computer models, maps, and other illustrations? How will uncertainties be explicitly transmitted to the model users?

**EVALUATION OF DOE RESPONSE**

- DOE's response indicates that it is aware of the problem raised by this question. DOE notes that there is a wide variety of techniques that can be used to describe local variability in data within a block model. These techniques include kriging variance and geostatistical simulation.
- DOE does not commit to or specify using any particular technique in future model development. The methodology for model development should be specified before the data is collected. (See evaluation of DOE's response to COMMENT 55).
- DOE does not commit to describing how local variability in data will be presented in the block model.
- DOE should describe a formalized system and/or approach for interaction between model creator and model user that conveys uncertainties inherent in a particular model.
- NRC should review study plans and resultant block models to assess whether or not local variability in data is adequately preserved and presented. Progress toward closure of this question will depend on these reviews.
- The staff considers DOE's response incomplete and therefore considers that this question remains open.

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QUESTION 9

The SCP (p. 8.3.1.4-98) states that "determination of multiple properties from the same specimens is important for correlating variability of different parameters with non-uniform measurement support." How will this testing strategy be implemented?

EVALUATION OF DOE RESPONSE

- The first paragraph of the DOE's response explains the mechanics of how samples presently are allocated for various tests. No supporting rationale nor prioritizing procedures are given or referenced.
- The second paragraph references a study plan process, but presents insufficient detail to allow an evaluation as to whether or not Question 9 has been answered.
- Of particular concern is that the DOE's response does not address the specific question raised, namely how sequential testing of multiple properties on the same samples will be implemented.
- DOE's response states that "The U.S. Department of Energy and the U.S. Nuclear Regulatory Commission review of the various study plans involved should assist in ensuring that ..." It is inappropriate for DOE to rely on NRC staff review (See also SCA Comment 76).
- Progress toward answering the question may result from a review of the study plan process mentioned in the DOE's response.
- The staff considers this question open.

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QUESTION 10

The proposed method for formulation of a three-dimensional block model by dividing it into numerous orthogonal blocks is based on the assumption that each block is sufficiently small and that the parameter of interest may be treated as constant within the block. How will the method described in the SCP account for possible variability within the blocks?

EVALUATION OF DOE RESPONSE

- DOE's response to this question does not describe how variability within a block will be described but instead DOE states that different block sizes may be used for different block properties or purposes. DOE states that block size may be a function of variability of a property or sensitivity to that variability.
- DOE's response does not specify whether or not blocks will have a constant parameter value within each block, or how variability within a block might be accounted for.
- DOE hints that geostatistical methods are evolving which may be useful in addressing the issues raised by QUESTION 10, but makes no commitment as to what exactly will be done, in affect deferring any decision.
- DOE should specify how it intends to determine block sizes and how intra-block variability will be represented.
- The staff considers that DOE is deferring resolution of this question and therefore considers this question to remain open.

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QUESTION 11

What is the rationale for the plan to start drilling prior to approval of study plans for drilling?

EVALUATION OF DOE RESPONSE

- DOE notes that no drilling will begin before management approval of an integrated drilling program to provide data needs for all SCP studies and that the schedule will undergo a series of revisions and refinements. DOE indicates that the demonstration of air-drilling feasibility has been accomplished.
- The NRC staff considers that the response to this question is adequate and the question is therefore resolved.

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**QUESTION 16**

**What methods will be used to determine the impact of ground motion from underground nuclear explosions (UNEs) on repository design?**

**EVALUATION OF DOE RESPONSE**

- **DOE's response indicates that a Study Plan for Activity 8.3.17.3.3.2 (Select or Develop Empirical Models for Ground Motion From Underground Nuclear Explosions) of the SCP will describe the approach used to develop empirical models of ground motion. The response indicates that standard linear regression and two-dimensional finite difference calculations will be used. DOE notes that on the basis of current information ground motion generated by natural seismicity, and not UNE-generated ground motion, will control repository seismic design.**
- **DOE indicates that stresses predicted at Yucca Mountain for the design basis UNE were small.**
- **The NRC staff considers this question resolved.**

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**QUESTION 17**

What activities are planned to investigate the effects of radiation on thermal and mechanical rock properties?

**EVALUATION OF DOE RESPONSE**

- DOE states that "Scoping studies of the effects of radiation are currently being incorporated into Study Plan 8.3.4.2.4.3."
- Progress toward resolution of the question will be deferred until NRC review of the study plan.
- The staff considers this question open.

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QUESTION 18

How will the allowable movement on joints be related to rock-mass strength?

EVALUATION OF DOE RESPONSE

- DOE's response indicates that allowable joint movement may be an important design criterion and notes that there are several numerical models which can use joint data in varying degree to predict joint movement. DOE notes that comparisons of predicted and experimental joint movement will lead to more reliable models and predictions through model revision.
- DOE does not explain how allowable joint movement is related to rock mass strength. However, DOE explains the relevance of rock mass response in evaluating opening performance. Joint movement is an important aspect and potential criterion in evaluating rock mass response.
- The NRC staff considers this question resolved.

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QUESTION 20

What site information will be used for product 1.11.3-3, Vertical vs. Horizontal Emplacement Orientation Decision (pp. 8.3.2.2-48 and 8.3.2.2-50)?

EVALUATION OF DOE RESPONSE

- DOE states that future Site Characterization Progress Reports should provide clarification as to how site information will be used to substantiate the emplacement orientation decision. Specifically, DOE notes that information in SAND88-3073 should be included in any SCP update.
- DOE does not explain what SAND88-3073 is or provide a reference for it.
- Progress toward closure may result from review of SAND88-3073.
- DOE defers the closure of this question until future Site Characterization Progress Reports are submitted. The staff considers that this question remains open.

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QUESTION 21

What process was implemented to assure that the list of parameters for performance goal C2 (radiation shielding properties of the host rock, given on p. 8.3.2.3-30, is comprehensive, and the expected parameter value (e.g., 65 percent saturation of host rock) are realistic?

EVALUATION OF DOE RESPONSE

- DOE's response does not answer the question, i.e. no process is identified by which it has been assured that the list of parameters for performance goal C2 (radiation shielding properties of the host rock) is comprehensive, and that the expected parameter values (e.g. 65 percent saturation of the host rock) are realistic.
- The concern expressed by the question is further enhanced by the first sentence of the DOE's response, which, in essence, contains an admission that a performance or design parameter, the water content of the host rock, listed in Table 8.3.2.3-3 of the SCP for performance goal C2, may be irrelevant.
- The second sentence of the DOE's response suggests that "for vertical emplacement, engineering materials on the invert of the drift may also provide sufficient shielding." Emplacing engineering shielding materials on the floor appears to be a repository design approach not discussed in the SCP.
- The third sentence of the DOE's response states that "these possibilities will be evaluated when site data and detailed repository designs are available." This sentence reinforces the concern expressed in Question 21 that no process was implemented to assure that all necessary information will be gathered during site characterization.
- The concern about completeness of the planned data gathering effort is further enhanced by the first sentence of the second paragraph of the DOE's response : "To be complete, a fracture parameter could have been added to the list of parameters for performance goal C2 ... in the event that open fractures are found and the engineering materials are not sufficient." This sentence further enhances the impression that no systematic process has been applied to identify information needs, and to design the corresponding site characterization activities.
- No rationale supports the concluding statement of the DOE's response that "existing SCP activities for determining fracture geometry and properties ... will provide the information necessary."
- Progress toward closure of this question will require a rational development of site

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characterization needs with respect to radiation shielding.

- The non-responsiveness of the DOE's response to the first two items in the Basis of the NRC question raise the level of concern about the adequacy of the SCP sections being questioned.
- The staff considers this question open.

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QUESTION 22

What is the rationale for selecting some of the tentative performance goals given in Tables 8.3.2.5-1 and 2?

EVALUATION OF DOE RESPONSE

- DOE's response does not answer the question, i.e. does not provide a rationale by which the tentative performance goals have been selected.
- DOE's response states that "these goals will be evaluated as part of the design process planned for the Advanced Conceptual Design and License Application Design and any additional rationale for these goals will be provided as appropriate."
- DOE's response refers to the DOE's response to NRC Comments 1 and 43 regarding "goals". DOE's response to NRC Comment 1 in particular contains a lengthy discussion of how the goals were established, and essentially defers closure of the concerns about goals to future studies.
- Progress toward closure of Question 22 will have to await NRC staff review of the Advanced Conceptual Design and License Application Design. Progress toward closure will be made if the design and supporting documents provide a convincing rationale for the goals.
- The staff considers this question open.

NOTE: In light of the references in the DOE's response to the DOE's responses to Comment 1 and 43 it would seem desirable to coordinate this NRC evaluation with the NRC evaluations of the responses to Comments 1 and 43.

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### QUESTION 23

Section 8.3.5.20 discusses verification of computer codes and validation of models, and makes the following points.

1. "Verification studies are used to demonstrate that the numerical values produced by a computational procedure correspond to mathematical formulas on which they are based" (p. 8.3.5.20-2). (Note that no site characterization data are required for verification studies.)
2. The validation problem can be separated "into two aspects: (1) ascertaining when the model has achieved a good representation of the system, and (2) comparing predictive results to appropriate observation and experimental results" (p. 8.3.5.20- 8).

What are the plans for code verification and model validation, presented in Section 8.3.2.5.7, for each analysis type?

### EVALUATION OF DOE RESPONSE

- DOE's response indicates that it will provide plans for its verification process for each of the detailed type of design analyses through the established design control documents. DOE also describes its software quality assurance plan.
- DOE does not describe any plans or procedures for model validation.
- DOE should describe its plans for model validation before affected site characterization activities begin. Validation of computer codes after experiments have been performed may raise issues concerning uniqueness of solutions.
- The NRC staff considers DOE's response incomplete and therefore considers that the question remains open.

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**QUESTION 24**

**What is the justification for concluding that the shaft liner does not provide structural support for the formation and that the removal of the liner does not significantly modify the permeability?**

**EVALUATION OF DOE RESPONSE**

- **DOE's response presents a logical and clear explanation as to why the modified permeability zone calculations result in a conservative estimate with regard to evaluating the influence of liner removal.**
  
- **DOE's response explains how the concerns expressed in the Basis to the NRC Question about apparent contradictions with regard to rock/liner interactions are implicitly accounted for in the analyses supporting the SCP statement.**
  
- **The staff considers this question closed.**

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QUESTION 25

The SCP and supporting documents (e.g., Fernandez et al., 1987) emphasize characterization and design "to ensure that water will not compromise the containment and isolation of radionuclides from the accessible environment" (p. 8.3.1.1-1). How are air flow characteristics of the site, particularly faults, to be evaluated?

EVALUATION OF DOE RESPONSE

- DOE's response states that evaluation of airflow properties, to varying degrees, are planned in a number of studies in the SCP. The referred studies in the SCP focus on airflow properties (namely, bulk permeability and gas composition) for a rock mass with joints and fractures. These studies do not address airflow properties relating to faults.
- Also in its response, DOE references study plans for further details on how the air flow characteristics will be determined. It is not clear whether determination of air-flow properties for faults will be included.
- Progress toward closure of the question will require review of the referred study plan to identify whether they provide adequately for characterization of potential air flows along faults and an analysis of the potential influence of airflow along faults on isolation and containment, and, if necessary, on sealing requirements.
- The staff considers this question open.

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**QUESTION 26**

There is an important inconsistency between Tentative Design Goals (Table 8.3.3.2-1) and Design-Basis Performance Goals (Table 8.3.3.2-5) for shafts and ramps inflow for the first 400 years after closure. What are the potential impacts of inconsistencies in tentative goals and design-basis performance goals for shafts and ramps?

**EVALUATION OF DOE RESPONSE**

- DOE's response clarifies the source of the difference between the tentative design goal and the design-basis performance goals (although it seems likely that the page number cited for the insertion in the first paragraph of the response is incorrect).
- The staff considers this question closed.

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QUESTION 27

Does ES-1 have 150 m<sup>3</sup> water storage capacity at base of shaft for attaining the tentative design goal identified on p. 8.3.3.2-13?

EVALUATION OF DOE RESPONSE

- In response to this question, DOE explains that the design goal for water storage capacity at the base of the ES-1 was based on preliminary calculations in Fernandez et al. (1984; SAND83-1778) and later calculation provided by Fernandez et al. (1987; SAND 85-0598) indicated that this tentative goal would be met.
- In the SAND85-0598 report, Fernandez, et al. stated that "If the ESF was backfilled with a crushed tuff having a porosity of 0.3, the storage capacity would be about 200 m<sup>3</sup> in the shaft sumps. This volume is computed assuming a tail shaft 15 and 31 m long in ES-1 and ES-2, respectively." It is apparent that the storage capacity of 200 m<sup>3</sup> is the total storage capacity of both sumps. Assuming the diameter of the shafts is 4.3 m (note that excavated shaft diameter instead of shaft internal diameter should be used in the calculation), the calculated storage capacity is a little more than 200 m<sup>3</sup>. This report also indicated that if the storage capacity of the ESF drift were taken into account, additional capacity of about 630 m<sup>3</sup> would be available. It would seem that DOE inappropriately used the information by assigning the design goal for water storage capacity at the base of the ES-1 to be 150 m<sup>3</sup>.
- DOE's response further indicates that the design goal should be changed from 150 m<sup>3</sup> to 50 m<sup>3</sup>, since even under severe precipitation events the drainage into ES-1 ranges from 0 to 50 m<sup>3</sup>. The value of 50 m<sup>3</sup> was obtained through a series of calculations performed by Fernandez et al. under several scenarios.
- The staff considers that this question is resolved.

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QUESTION 28

If it is decided that ES-1 will penetrate the Calico Hills unit, what will be the impacts on the current sealing program and issue resolution strategy for Issue 4.4?

EVALUATION OF DOE RESPONSE

- DOE's response states that "there are two primary areas where penetration into the Calico Hills unit could modify the Yucca Mountain Project repository sealing program: (1) geochemistry and (2) seal emplacement feasibility."
- The scope of the listed program impacts seems extremely narrow. Not addressed for example are such topics as:
  - Performance requirements and allocations
  - Seal design
  - Modified permeability zone characteristics
  - Impact of liner removal in the Calico Hills (which is much weaker, and deeper, hence presumably more highly stressed, than the Topopah Spring - see also DOE's response to SCA Question 24).
  - Seal testing
- Progress toward closure of this question will require a recognition and identification of sealing needs, e.g. by means of performance analysis, for penetrations, especially major ones such as shafts and drifts, through and within the Calico Hills.
- DOE's response to Question 28 references the DOE response to Comment 16. The latter response discusses extensive drifting and numerous holes that may be drilled in the Calico Hills, further enhancing the concern about eventual sealing requirements in the Calico Hills.
- DOE's response refers to an ongoing Calico Hills Risk Benefit study and the Exploratory Shaft Facility Alternative Study. Progress toward closure of Question 28 may be possible if these studies adequately address sealing concerns of penetrations in the Calico Hills.
- The staff considers this question open.

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QUESTION 29

What is the basis to justify that the references cited on p. 8.3.3.2-58 present results representative of the conditions present at the Yucca Mountain site?

EVALUATION OF DOE RESPONSE

- DOE's response clarifies that "the DOE did not intend the survey of literature to be used to set test conditions for sealing test" and makes a commitment to identify the proper test conditions when laboratory analyses are proposed in the Yucca Mountain Project repository sealing program.
- The staff considers this question closed.

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QUESTION 41

Why is 10 CFR 60.132(a), "Facilities for receipt and retrieval of waste" not given as a regulatory basis for the resolution of Issue 2.4?

EVALUATION OF DOE RESPONSE

- DOE's response claims that no additional site characterization information needs are required to support 10 CFR 60.132(a), only the requirements for the design of the surface facility itself.
- Additional site characterization information would be needed if significant amounts of retrieved waste were to be stored on the surface.
- DOE should explain its plans for surface storage of retrieved waste and if necessary, modify site characterization information needs.
- The NRC staff considers DOE's response incomplete and therefore considers that this question remains open.

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QUESTION 42

Where are the analyses given to support the expectation that vertical emplacement holes will remain stable throughout the retrieval period?

EVALUATION OF DOE RESPONSE

- DOE's response acknowledges that a specific vertical-emplacment hole stability analysis has not yet been performed and commits that the analysis referred in the comment will be performed during repository advanced conceptual design.
- Progress toward closure of the question will be made during the staff review of the advanced conceptual design analyses.
- The staff recognizes that, as stated in the DOE's response, "in situ experiments conducted during site characterization will provide important information regarding emplacement hole "stability"." Less clear from the response and from the SCP is whether all the necessary information will be gathered.
- The staff considers this question open.

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**QUESTION 56**

What is the justification for selecting a tolerance of 5 cm fault displacement?

**EVALUATION OF DOE RESPONSE**

- DOE explains that the 5 cm fault displacement tolerance was established using engineering judgment and proposed design requirements for an air gap around the waste package. DOE also notes that the experimental program for evaluating the potential effects of fault displacement would be defined as the results of the Exploratory Shaft Facility Alternatives Study become available.
- The relation between the experimental program for evaluating the potential effects of fault displacement and the Exploratory Shaft Facility Alternatives Study is not clear.
- DOE does not describe specific plans aimed at justifying an acceptable tolerance for fault displacement.
- Progress toward closure of this question may result from review of the Exploratory Shaft Facility Alternatives Study.
- The NRC staff considers DOE's response to this question incomplete and therefore considers that this question remains open.

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QUESTION 57

How has the effect of drilling of possibly three multipurpose boreholes (including a borehole between ES-1 and ES-2) been considered with respect to (i) design flexibility of Upper Demonstration Breakout Room due to potential interference, and (ii) interference with underground testing at the main test level?

EVALUATION OF DOE RESPONSE

- DOE claims that the boreholes in the SCP were selected based on the borehole siting criteria in the SCP to be well away from excavated openings and outside the any experiment influence zones. DOE claims that the siting constraints for the UDBR and the multipurpose boreholes can be met without conflict.
- DOE's response does not address the issue of flexibility in locating the UDBR. If three boreholes are drilled prior to shaft sinking, the possible orientations for the UDBR are greatly reduced.
- DOE has not substantiated its claim that the locations for three multipurpose boreholes given in the SCP would be sufficiently far from excavated openings or experiments taking into account possible hole deviation.
- DOE should explain why flexibility is not needed in orienting the UDBR and provide a diagram of the location of the multipurpose boreholes and underground excavations and experiments taking into account possible hole deviations to justify its claim concerning no interference.
- The NRC staff considers DOE's response to this question incomplete and therefore considers that this question remains open.

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QUESTION 58

How does the ESF design described in the SCP provide the flexibility to accommodate in situ testing of waste packages should it be considered desirable or necessary by DOE?

EVALUATION OF DOE RESPONSE

- DOE explains that no tests using radioactive material are presently planned for the ESF. However, DOE recognizes that tests which investigate radiological effects may be required in the future and committed to consider revisions to the plans for ESF testing and the ESF facility if such testing is required.
- DOE's response focuses on the use of radioactive materials in ESF testing rather than the subject of the question (i.e. the flexibility (including compliance with radiological safety related regulatory requirements in 10 CFR Part 60) of the ESF design described in the SCP to accommodate in situ testing of waste packages if it is considered necessary by DOE at a later date).
- The NRC staff considers DOE's response incomplete and therefore considers that this question remains open.

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QUESTION 59

Thermal tests such as the heater experiment in Unit TSw1, canister scale heater experiment, heated block test, and heated room experiment are planned to run for relatively short durations (1 month, 30 months, 100 days, 36 months, respectively). What is the basis for the selected test duration?

EVALUATION OF DOE RESPONSE

- The DOE references Bauer et al. (1988) as the basis for the selection of the test duration. This raises the following concerns:
  - Bauer et al. (1988) repeatedly emphasize the preliminary nature of their analyses, e.g. in the title of their report, in the abstract, in the introduction, and repeatedly throughout their report. They stress the simplifying assumptions underlying their analyses, and the need for more comprehensive and realistic calculations.
  - The primary criterion used in Bauer et al. (1988), and consequently apparently in the SCP, is the temperature distribution and the resulting thermomechanical response, primarily the stress field. While of importance for test design, the basis of Question 59 does not question this aspect of the experimental design.
- While the SCP discusses a heated room test duration of 36 months, the analysis in Bauer et al. (1988) is for a 40 month test duration. The SCP acknowledges that running the test for over 40 months may require additional stand-off distance (p. 8.4.2.-126).
- The first two concerns expressed in the basis of the NRC question are not addressed in the DOE's response.
- The concern expressed in the third item in the basis of the question, i.e. whether sufficient time is allowed in the canister-scale heater test to allow a thermal "overdrive", is answered with a reference to Bauer et al. (1988). Review of the reference confirms that overdrive heating is possible, with a considerable margin of safety. This item of the Basis of Question 59 can be considered closed.
- DOE's response does not address the fourth and last item in the Basis for Question 59.
- DOE's response includes the statement that "these durations are, however, estimates of the time necessary to accomplish the scope of each test and do not mean that at the end

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of the estimated time the test would be terminated. The decision to terminate a test would be based on test results or other experimental factors, e.g., the attainment of steady-state temperature profiles or the confirmation of thermal distributions. The rationale behind the criteria for the confirmation for the termination of each test would be developed in the study plan." The narrow focus of the cited criteria for test termination, primarily temperature distributions, confirm the main concern underlying Question 59, that the proposed test durations may be selected on too narrow a basis, e.g. not including investigations of the host rock response to prolonged exposure to likely in situ conditions.

- Progress toward closure of Question 59 will require that the rationale to be included in the study plan addresses the items in the basis to Question 59 that remain open.

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**QUESTION 60**

**What is the timing of the exploratory shaft radial borehole tests? What is the basis to justify that operational interference for these tests has been considered?**

**EVALUATION OF DOE RESPONSE**

- **DOE's response explains the timing of the exploratory shaft radial borehole tests and the procedures for mitigating potential operational interference.**
- **The NRC considers DOE's response adequate and considers this question resolved.**

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QUESTION 61

How will design changes (as outlined in 10 CFR 50, Appendix B, Item III, paragraph 4) be made in a timely and appropriate manner during the design and construction of the ESF?

EVALUATION OF DOE RESPONSE

- DOE's response acknowledges that some major design changes may require significant time for design and approval and claims that the ESF design attempts to allow extra facility capacity to accommodate most changes. DOE explains that all design changes would be controlled by architectural-engineering procedures that have been developed.
- No reference is provided for the architectural-engineering procedures that have been developed.
- No explanation is given for how time to implement changes will be estimated.
- DOE should provide the architectural-engineering procedures which will be used to implement design changes. DOE should describe how time to implement changes will be estimated. NRC should review the requested information and provide comments as appropriate.
- The NRC staff considers DOE's response incomplete and therefore considers that this question remains open.

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**QUESTION 62**

What is the basis for the design requirement of a 30 m separation between the ESF and potential waste emplacement panels, and for a design decision to allow waste emplacement within approximately 500 ft. of the exploratory shafts?

**EVALUATION OF DOE RESPONSE**

- DOE's response indicates that unsaturated flow within the repository horizon was hypothesized to be primarily vertical and based on this hypothesis the 30-meter separation between the ESF and potential waste emplacement panels was deemed adequate to ensure that the Exploratory shaft Facility would not become a preferential pathway for radionuclide transport. Similarly, because of the assumed vertical flow, the 500 foot separation between the ESF and emplaced waste was deemed adequate. DOE commits to changing the repository design if larger distances are needed.
- DOE provided no explanation for the claim that the planned minimum separations were considered sufficient to support ESF design.
- DOE should provide justification in the form of calculations or design analysis for its claim that the minimum separation distances are sufficient to support ESF design.
- DOE states that additional studies are planned, with the results to be reported in Yucca Mountain Project Status Reports.
- Progress toward closure of this question will have to await review of the planned additional studies.
- The NRC staff considers DOE's response incomplete and therefore considers that this question remains open.

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**QUESTION 63**

What is the justification for certifying (Appendix C.3 of DAA) that all TAR reviewers were not principal contributors to ESF Title I Design or to the Subsystems Design Requirements Document (SDRD) which was used for ESF Title I Design in view of the documentation in the DAA showing that some of the TAR reviewers worked on the ESF Title I Design and/or SDRD?

**EVALUATION OF DOE RESPONSE**

- DOE's response claims that the standard of independence for Technical Assessment Review (TAR) team members for the review of ESF Title I design was appropriate and that the standard was met. DOE argues that the final decision regarding standards for conflict of interest and independence of DOE reviewers must remain the prerogative of the DOE. DOE goes on to argue that the quality of the review would have suffered if the team had only been comprised of members who had no prior connection with, and knowledge of ESF Title I design.
- DOE's claim that totally independent review of Title I design would have reduced the review quality is unfounded. As evidence that a totally independent group can make important contributions, compare the review comments made to date by the Technical Review Board (TRB) and the TAR.
- DOE's assertion that standards for independence of TAR team members were appropriate and that the standards were met is simply claimed without explicit justification. Examples listed by NRC are unchallenged.
- The NRC staff acknowledges that decisions regarding standards for conflict of interest and independence of DOE reviewers remain with DOE. However, the NRC staff reiterates its recommendation that DOE make arrangements to reach mutual agreement with NRC staff on acceptable standards for conflict of interest and independence of reviewers in the design review processes. The NRC staff considers such standards necessary to insure credibility in the design review process.
- The NRC staff considers DOE's response incomplete and therefore considers that this question remains open.