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AUG 8 1991

ACNW SECOND TRANSMITTAL

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

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

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

SUBJECT: TRANSMITTAL OF FINAL SITE CHARACTERIZATION ANALYSIS (SCA) RESPONSE EVALUATION PACKAGE TO THE ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW) FOR THE AUGUST 1991 ACNW MEETING

On July 29, 1991, the Division of High-Level Waste Management (HLWM) transmitted to ACNW the draft package containing the NRC staff evaluation of the U.S. Department of Energy (DOE) SCA responses. Having completed management review of that draft package, HLWM has transmitted its final package to DOE and is hereby transmitting five copies of that package to ACNW. No substantive changes were made to the draft package in finalizing it.

If you have any questions or require further information, please contact King Stablein, the project manager for the SCA response evaluation package, on extension 20446.

(Original Signed by John Linehan)

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

Enclosure: As stated see encl kept in shelf

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

JUL 3 1 1991

Dr. John W. Bartlett, Director
Office of Civilian Radioactive Waste Management
U.S. Department of Energy RW-1
Washington, DC 20585

Dear Dr. Bartlett:

On December 14, 1990, the U.S. Department of Energy (DOE) transmitted its responses to the open items-- 2 objections, 133 comments, and 63 questions--presented in the U.S. Nuclear Regulatory Commission's (NRC) Site Characterization Analysis (SCA) of DOE's Site Characterization Plan (SCP) for the Yucca Mountain, Nevada proposed repository site. While DOE addressed each one of NRC's SCA open items, it did not indicate, either in its transmittal letter or in the responses themselves, that it expected the SCA open items to be closed on the basis of the contents of the responses. In fact, as the NRC staff expected, DOE indicated in the transmittal letter that "Many of the comments in the SCA cannot be fully resolved in the absence of new site information..."

Nevertheless, DOE has made significant progress toward closing the two objections, which it has the responsibility for closing prior to proceeding with site characterization work related to those objections. Regarding the objection that DOE did not have a qualified quality assurance (QA) program in place for site characterization activities, there has been partial closure on several of the particulars involved in the objection. The NRC staff has concurred with DOE's findings that three DOE contractor programs are acceptable for new site characterization activities, four DOE contractor programs are acceptable for new site characterization activities with minor exceptions, and the DOE Headquarters and DOE Yucca Mountain Site Characterization Office programs are acceptable to begin limited new site characterization activities in Midway Valley.

With respect to the second objection, that DOE had not demonstrated the adequacy of the design control process under which the exploratory shaft facility, now exploratory studies facility, (ESF) was prepared nor the adequacy of the design itself, DOE has been conducting a study of alternatives to the ESF design in the SCP and is scheduled to select a new design later this year. NRC met with DOE in January 1991 to discuss a number of specific concerns related to this objection. The meeting enabled NRC to gain a better understanding of what DOE was doing in this area, especially with regard to the identification and incorporation of regulatory requirements. Based on this and other interactions with DOE, it appears that DOE has begun to adequately consider the NRC staff concerns in its alternatives study. However, before NRC can draw a final conclusion, it will have to receive and review DOE's formal submittals on the objection.

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In its cover letter transmitting the SCA responses, DOE responded in general terms to several major site characterization study areas--iterative performance assessments, tectonic phenomena investigations, technical integration, and alternative conceptual models--highlighted for DOE management attention in NRC's letter transmitting the SCA to DOE (Bernero to Rousso, July 31, 1989), and indicated it has ongoing work in these areas. NRC encourages DOE to provide NRC with the reports documenting what has been and what will be done in these areas for NRC review as soon as possible so that NRC and DOE can come to early agreement on approaches in these key areas.

With an understanding of the necessary limitations in some of the responses to the 198 individual open items, the NRC staff has reviewed the DOE responses to determine which of the open items could be closed on the basis of the information provided. The staff has done an evaluation of each response. For each of those items which must remain open at this time, the evaluation identifies any concerns that the staff has with the approach discussed in the response, and, where possible, suggests what the next steps might be to make progress toward closure of the open item.

When the NRC staff identified the open items in the SCA, it did so based upon the level of detail that was expected to be contained in the SCP. This level of detail was agreed upon at the May 7-8, 1986 NRC-DOE Level of Detail for Site Characterization Plans and Study Plans Meeting. Accordingly, when the staff considered whether an open item was to remain open or be closed, it evaluated the DOE response in terms of whether the information provided was sufficient, at the SCP level of detail, to close the open item. If DOE recognized the concern, and provided information at the appropriate level of detail to address the concern, the NRC staff concluded that the open item was closed.

For many open items, DOE recognized the concerns but deferred the SCP-level details of its response to issuance of a future document (e.g., Exploratory Studies Facility Alternatives Study). In such cases, the NRC staff has left the open item open pending its review of the specified DOE submittals.

In the particular cases where DOE recognized the concerns but deferred some or all details of its response to issuance of one or more study plans, the NRC staff had to determine whether the DOE response itself contained enough information, at the SCP level of detail, to close those open items. In some instances, DOE's deferral of the SCP level of detail to study plans necessitated leaving the open items open pending NRC staff review of the study plans, even though the NRC staff would not have ordinarily expected to need to review study plans, with their greater level of detail than that required for the SCP, to close out SCP-related open items.

For other responses, where DOE deferred its response until certain site characterization data could be obtained and analyzed, the NRC staff considered the open items open. Also, in cases where DOE disagreed with the NRC concern but did not persuade the NRC staff of the insubstantiality of the concern, or where DOE recognized the NRC concern but presented an approach to resolving that concern about which the NRC staff had questions, the items were considered open.

The results of the NRC staff review are contained in the enclosure to this letter. Evaluations of each DOE response are presented, as well as Table 1, which indicates the current status of each SCA open item. Fifty-nine of the 198 open items (38 of the 133 comments and 21 of the 63 questions) were closed on the basis of the DOE responses.

Closure of many of the remaining open items has been deferred until the NRC staff reviews various DOE documents identified in the DOE responses. To facilitate the process of reaching closure on these open items, DOE should, in its transmittal letters accompanying such documents, specify which open items are addressed and where, in a given document, the information intended to close an open item is presented.

For purposes of tracking DOE's activities and progress toward closure of NRC's SCA open items, DOE should report this information in its SCP progress reports. I have previously requested that this be done in my letter transmitting the SCA to DOE (Bernero to Rousso, July 31, 1989) and in my letter to you providing the NRC staff comments on DOE's first SCP progress report (Bernero to Bartlett, June 25, 1990). I consider this to be an important component of the SCP progress reports and necessary for the NRC staff to be assured that the NRC SCA open items, as well as other open items, such as those related to NRC staff reviews of study plans, are receiving appropriate attention in the DOE site characterization program.

In my July 31, 1989 letter transmitting the SCA to DOE, I stated that "The NRC considers all concerns identified in this letter and in the SCA to be serious and encourages DOE to give full attention to each in an attempt to resolve them early during site characterization." This statement represents NRC's continuing position. DOE's responses indicate that attention is being directed to addressing the SCA open items. The evaluations provided with this letter are intended to assist DOE in its efforts to close the remaining SCA open items. NRC urges DOE to continue to work toward closure of those open items and is prepared to meet with DOE as necessary to ensure that the NRC concerns are fully understood and to progress toward mutually agreeable approaches for closure of the open items.

Please give me a call if you wish to discuss any issues or believe the interaction between our staffs would help clarify the contents of this letter or its enclosures.

Sincerely,

Robert M. Bernero, Director
Office of Nuclear Material Safety
and Safeguards

Enclosure: 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
W. Barnard, NWTRB
C. Thistlethwaite, Inyo County, CA

Recvd w/ an letter dtd. 8/8/91

TABLE 1

STATUS OF SCA OPEN ITEMS

SCA Open Item		Status
OBJECTION	1	Open
	2	Open
COMMENT	1	Open
	2	Open
	3	Open
	4	Open
	5	Open
	6	Open
	7	Open
	8	Open
	9	Open
	10	Open
	11	Open
	12	Open
	13	Closed
	14	Closed
	15	Open
	16	Open
	17	Closed
	18	Open
	19	Open
	20	Open
	21	Open
	22	Open
	23	Closed
	24	Open
	25	Open
	26	Closed
	27	Closed
	28	Closed
	29	Closed
	30	Closed
	31	Open
	32	Open
	33	Open
	34	Open
	35	Open.
	36	Open
	37	Closed
	38	Closed
	39	Closed
	40	Closed

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TABLE 1 (Continued)

STATUS OF SCA OPEN ITEMS

SCA Open Item		Status
COMMENT	41	Closed
	42	Open
	43	Open
	44	Closed
	45	Open
	46	Closed
	47	Open
	48	Open
	49	Open
	50	Closed
	51	Open
	52	Open
	53	Open
	54	Closed
	55	Open
	56	Open
	57	Open
	58	Closed
	59	Open
	60	Open
	61	Open
	62	Open
	63	Open
	64	Open
	65	Closed
	66	Open
	67	Closed
	68	Open
	69	Open
	70	Closed
	71	Open
	72	Open
	73	Open
	74	Open
	75	Open
	76	Closed
	77	Open
	78	Closed
	79	Open
	80	Open

TABLE 1 (Continued)

STATUS OF SCA OPEN ITEMS

SCA Open Item		Status
COMMENT	81	Open
	82	Open
	83	Closed
	84	Open
	85	Open
	86	Open
	87	Open
	88	Open
	89	Open
	90	Open
	91	Open
	92	Closed
	93	Closed
	94	Closed
	95	Open
	96	Open
	97	Closed
	98	Open
	99	Open
	100	Open
	101	Open
	102	Open
	103	Open
	104	Open
	105	Open
	106	Open
	107	Closed
	108	Open
	109	Open
	110	Open
	111	Closed
	112	Open
	113	Open
	114	Closed
	115	Open
	116	Open
	117	Open
	118	Open
	119	Open
	120	Open

TABLE 1 (Continued)

STATUS OF SCA OPEN ITEMS

SCA Open Item		Status
COMMENT	121	Open
	122	Open
	123	Open
	124	Closed
	125	Closed
	126	Closed
	127	Open
	128	Open
	129	Closed
	130	Open
	131	Closed
	132	Open
	133	Closed
QUESTION	1	Open
	2	Closed
	3	Open
	4	Closed
	5	Open
	6	Closed
	7	Closed
	8	Open
	9	Open
	10	Closed
	11	Closed
	12	Open
	13	Closed
	14	Open
	15	Open
	16	Closed
	17	Open
	18	Closed
	19	Closed
	20	Open
	21	Open
	22	Open
	23	Open
	24	Closed
	25	Open

TABLE 1 (Continued)

STATUS OF SCA OPEN ITEMS

SCA Open Item		Status
QUESTION	26	Closed
	27	Closed
	28	Open
	29	Closed
	30	Open
	31	Open
	32	Open
	33	Open
	34	Open
	35	Open
	36	Open
	37	Open
	38	Open
	39	Open
	40	Open
	41	Open
	42	Open
	43	Closed
	44	Open
	45	Open
	46	Open
	47	Open
	48	Closed
	49	Open
	50	Closed
	51	Open
	52	Closed
	53	Open
	54	Closed
	55	Open
	56	Open
	57	Open
	58	Open
	59	Open
	60	Closed
	61	Open
	62	Open
	63	Closed

Section 8.4.2.3.1 Exploratory shaft facility testing, operations, layout constraints, and zones of influence, pp.8.4.2-93/147

SCA 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, the process used to integrate currently available technical data into 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 states that it is conducting three studies: (1) Exploratory Shaft Facility (ESF) Alternatives; (2) Testing Prioritization Task; and (3) Calico Hills Risk/Benefit Analysis (CHRBA). DOE expects that these studies will provide information to address some of the issues involved in the objection.

- Discussion of ESF design related issues was not given in the DOE's response. These issues, which addressed the adequacy of the design control process and that of the ESF design itself, are the major concerns of this objection. DOE's response that the ESF Alternatives Study "evaluation" would be completed prior to the start of Title II (design) does not resolve these concerns at this time.

- Progress toward closure of this objection will involve DOE's submittal of the referenced three studies for NRC review and evaluation.

- DOE did not propose a closure of this objection in its response. The NRC staff considers that this objection remains open.

Section 8.6 Quality Assurance Program

SCA OBJECTION 2

Section 8.6 of the SCP describes the quality assurance (QA) program to be applied to site characterization activities including the exploratory shaft design and construction. Prior to conducting activities in the various program areas, it commits to having an appropriate program in place for those site characterization activities, which meets Subpart G of 10 CFR 60, and to qualify site exploration data supporting the license application. DOE has developed an acceptable approach for qualifying its QA program, but some of the milestones are not yet completed. In addition, although the information presented and referenced in the SCP on the responsibilities and independence of the QA managers is acceptable, the NRC staff is concerned that DOE will be impeded in demonstrating the ability to implement the approach because the QA management positions in DOE's headquarters (OCRWM) and field (YMPO) offices have not been filled with full time individuals with appropriate knowledge and experience. Also, staff QA concerns on the Design Acceptability Analyses (DAA) will need to be resolved. Finally, the Overview of the Site Characterization Plan incorrectly states that all organizations participating in the site characterization program have developed and are implementing a QA program that meets the NRC's requirements.

EVALUATION OF DOE RESPONSE

- Before the DOE QA program could be determined to be acceptable for start of new site characterization activities, it was necessary for OCRWM to verify and NRC to agree that the QA program as described in the QARD and QAPD was being effectively implemented. After an initial round of audits of participants' QA program implementation, NRC and DOE agreed at the April 27, 1990, QA meeting on the criteria to demonstrate that a QA program was being effectively implemented. The criteria included the following:

  (1) Review and resolve open QA program deficiencies identified by the DOE auditors that could have quality or technical impact on output products;

  (2) Identify the extent of the program implementation since the last DOE audit, including the areas of activity audited or surveilled and the end products produced;

  (3) Determine whether the QA program can be effectively implemented;

  (4) Identify what areas of the QA program are on hold; and

  (5) State the DOE position on whether the QA program is adequate for further implementation to conduct new site characterization activities.

- Based upon the NRC staff: (a) review of the QARD, QAPD, and participant's QAPPs, (b) observations of audits/surveillances, and (c) evaluation of information submitted by DOE addressing each of the above criteria, the

status of the QA program acceptance by NRC for new characterization activities is as follows:

Sandia National Laboratory and Lawrence Livermore National Laboratory - accepted (October 1990)
Fenix & Scisson, Holmes & Narver, Reynolds Electrical & Engineering Company, and U.S. Geological Survey - accepted with minor exceptions *(October 1990)
Office of Civilian Radioactive Waste Management/Headquarters and Yucca Mountain Project Office - limited acceptance **(January 1991)
Scientific Applications International Corporation/Technical and Management Support Services - under review
Los Alamos National Laboratory - accepted 5/29/91.
Raytheon Services Nuclear - TBD (Grandfather from FSN and H&N)

* procurement procedures, software QA program and personnel qualifications

** only for Midway Valley Trenching and Calcite-Silica Activities; open issues remain on QARD/QAPD and qualification audit 90-I-01 recommended actions.

- The NRC staff will make a determination whether the overall DOE QA program is acceptable for new site characterization activities upon satisfactory resolution of the above issues.

- The NRC staff considers this objection open.

Chapter 8	Site Characterization Program
Section 8.0	Introduction
Section 8.1	Rationale
Section 8.3	Planned Tests, Analyses, and Studies
Section 8.3.1	Site Program
Section 8.3.5	Performance Assessment Program

SCA COMMENT 1

Although the SCP commits to a systematic, iterative approach to identifying the information needed to support a license application (the Issue Resolution Strategy), the documentation in the SCP does not demonstrate that such a program is in place. While this comment includes several concerns not raised elsewhere, it also collects and summarizes concerns expressed in other comments, which collectively point to the absence of such a program.

EVALUATION OF DOE RESPONSE

- The NRC staff's interest in a systematic, iterative process results from the view that such an approach would best assure that the site characterization program will be of sufficient scope and appropriate detail to result in a complete license application. Comment 1 stated concerns about whether the systematic, iterative process described in the SCP would accomplish this goal. In its response, DOE agreed to use iterative performance assessment to refine the initial performance allocation described in the SCP. However, the responses to Comments 1 and 6 indicate that DOE has no plans to revise the hypothesis testing tables. The responses state instead that DOE will use data obtained during site characterization to test the hypotheses now articulated in the hypothesis testing tables. This approach does not resolve the staff's concern that the scope of the site characterization program may be too narrow and its concern about whether the studies identified in the SCP would adequately investigate the alternative conceptual models.

- Moreover, the DOE response addresses the recommendation of Comment 1 by referring to additional DOE documents that have either not been reviewed or not been evaluated by the NRC staff in the context of this comment. Therefore, Comment 1 is open. Closure will require NRC staff's review of the referenced documents to assure that its recommendations are being addressed. As a minimum the NRC staff needs to review the following documents:

  1. Test and Evaluation Plan
  2. Technical Support Documentation Management Plan
  3. Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program
  4. Baselined portions of the SCP

Section 8.1 Rationale for the Site Program

SCA COMMENT 2

The initial performance allocation, as documented in the SCP, contains logic gaps and hence does not provide assurance that the site characterization program will develop the required information.

EVALUATION OF DOE RESPONSE

- DOE's response refers to its response to SCA Comment 1. In response to this comment, DOE acknowledges that performance allocation, as outlined in the SCP, is incomplete and contains logical gaps between the identified performance allocation measures, goals, and parameters. It further states that "performance allocation cannot, [as initially conducted by the DOE], be expected to provide assurance that the site characterization program will develop the required information."

- The NRC staff recognizes that, as noted by DOE, performance allocation is part of an iterative process coupled with periodic performance assessments. This will result in a continuing refinement of the performance allocation goals. However, the NRC staff considers that increased confidence in the performance goals does not address the potential faulty logic underlying the development of these goals.

- The direction for the site investigations and activities and for the analysis of the data collected is contained in DOE's Test and Evaluation Plan (Rev. 0) and its Technical Support Documentation Management Plan. From its response, it appears that DOE will be using these plans "to base its decision regarding changes to the site characterization program [rather] than to conduct a retrospective examination of the program outlined in the SCP or a reworking of performance allocation logic."

- DOE expects that future technical reports, based upon site characterization data and performance assessments, will present further clarifications and more rigorous treatments and justifications of performance modeling assumptions, model elements, and parameter sensitivities.

- The NRC staff considers this comment to be open pending: (1) review of DOE's Test and Evaluation Plan (Rev. 0) and Technical Support Documentation Management Plan, and (2) receipt and review of the technical reports documenting the clarifications and more rigorous treatments and justifications of performance modeling assumptions, model elements, and parameter sensitivities.

Section 8.1 Rationale for the Site Characterization Program
Section 8.3 Planned Tests, Analyses, and Studies

SCA COMMENT 3

The SCP describes a program that relies heavily on the Formal Use of Expert Judgment (Expert Elicitation) to supply licensing information and data or to substitute for quantitative analyses. To the extent that a subjective approach is planned in situations where quantitative analyses based on empirical evidence are available, investigations that should be considered in the SCP are not considered. Thus, the SCP does not identify a full program of investigations needed for a complete, high-quality license application. Without stating criteria for the formal use of expert judgment, it is not clear that the license application will comply with the requirement of 10 CFR 60.24 that the application be as complete as possible in terms of information reasonably available.

EVALUATION OF DOE RESPONSE

- In Comment 3, the NRC staff was concerned that DOE's proposed program might rely so heavily on the formal use of expert judgment (expert elicitation) that needed investigations and quantitative analyses would not be undertaken in the site characterization program. The NRC staff notes that, in its response, DOE gives assurances that it does not intend to rely on expert judgment as a substitute for objective, quantitative analyses based on empirical data. DOE also states that it intends to preserve flexibility in defining the level of judgment or review needed in each specific case consistent with importance of the issue at hand to licensing.

- The NRC staff recognizes the need for such flexibility in determining what degree of formality in using (or level of) expert judgment should be used in a given case.

- The NRC staff was also concerned that DOE should state criteria for the formal use of expert judgment so as to be sure that the gathering of necessary information and conducting necessary analyses would not be precluded. In its response to Comment 3, DOE states that it plans to rely on expert judgment where appropriate mechanistic models are not available or where collected data are consistent with differing interpretations. The NRC staff considers that DOE is proposing two possible criteria for determining when to use expert judgment. Taken in the context of DOE's response, these criteria would apply when available objective information has been exhausted. The NRC staff considers these criteria to be appropriate as far as they go. However, the NRC staff is concerned not only that available information be fully used prior to reliance on expert judgment, but also that information that is reasonably obtainable, given the significance of the issue, be fully used. It is still unclear whether this second point has been accepted.

- For example, DOE does not commit itself to applying the criteria as early in the program as possible. It is important to recognize that some investigations must be planned early in the program. These may well

include investigations designed to clarify the interpretation of existing data. An early decision to use expert judgment can preclude timely initiation of needed investigations.

- Finally, DOE states that it intends to "control the use of subjective methods and the documentation of the results of any reviews or decision-making in accordance with established quality assurance (QA) procedures." The NRC staff agrees that such controls are needed and re-emphasizes the importance of including documentation of both facts and rationale for expert judgments.

- Specific points in the basis of SCA's Comment 3 were not addressed in DOE's response. DOE's response to Comment 3 represents an initial concurrence with stated principles about the use of expert judgment. The NRC staff considers this comment open until DOE has explicitly recognized the need to obtain any information that is reasonably obtainable given the importance of the issue.

Section 8.1 Rationale for the Site Characterization Program
Section 8.3.1.15 Overview of thermal and mechanical rock properties program

SCA 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

- o DOE's response defers several answers to future work:

  "Future Site Characterization Progress Reports will summarize the results of additional parametric sensitivity studies and any resulting changes to the goals and confidence levels in the geoengineering 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 if necessary."

- o DOE's response 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.

- o DOE's response further 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 Study 8.3.1.15.1.6 include that "Some of the data will be used for testing computer codes used in heat transfer and thermomechanical 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.

- o 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.

- o Progress toward closure of Comment 4 will require DOE's submittal of SCP Progress Reports containing the stated information and supporting documents such as study plans and technical procedures.

- o The NRC staff considers this comment open.

Section 8.2.2.1.1.4 Summary of waste package containment Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

SCA COMMENT 5

The SCP's revised technical interpretation of "substantially complete containment (SCC)" is closer to NRC's use of the phrase than the interpretation in the CDSCP but it adds a qualifier ("allowing for recognized technological limitations and uncertainties") and introduces a new term ("the set of waste packages") which in turn require explanation.

EVALUATION OF DOE RESPONSE

- DOE clarifies that in its interpretation of the performance objective for waste package containment, the term "the set of waste packages" applies to the entire set of waste packages, rather than individually to each package. This portion of the comment is considered closed by the staff.

- In its response, DOE has further amplified the phrase "allowing for technological limitations and uncertainties" by its emphasis on the limitations of available technologies for the production, closure and inspection of waste packages. DOE notes that uncertainties will arise from many sources, including (1) the "extrapolation of waste package environments over the entire spatial extent of the repository and over unprecedented time periods," (2) the "uncertainties in extrapolating the degradation modes and rates of engineered components," and (3) the "uncertainties introduced by the variability in the characteristics of the waste forms..." However, DOE does not explain how technological limitations and uncertainties might impact its demonstration of compliance with 10 CFR 60.113.

- The NRC staff considers this comment closed as to the definition of the term "the set of waste packages," but open as to the other issues of this comment.

Section 8.3 Planned Tests, Analyses, and Studies (8.3.1 through 8.3.1.17)

SCA COMMENT 6

The hypothesis testing (alternative conceptual model) tables included in Sections 8.3.1 (The Site Program), 8.3.2 (Repository Program), 8.3.3 (Seal Program), 8.3.4 (Waste Package) represent an improvement over the CDSCP in assuring the adequacy of the site program to provide data to distinguish among alternative models of site performance. However, the hypothesis testing tables contain some gaps and inconsistencies and in some instances cite studies that do not appear to distinguish among the alternative conceptual models listed.

EVALUATION OF DOE RESPONSE

- In the DOE response to Comment 1 (referred to by this comment's response) the "perceived gaps" in the hypothesis testing tables are attributed to an incomplete performance allocation for some investigations and the lack of site data. Despite its acknowledgment that the current performance allocation measures, goals, parameters and overall logic could be improved, DOE does not consider it productive "to conduct a ... reworking of the performance allocation logic" and has has no plans to revise the hypothesis testing tables.

- DOE states that "the hypothesis testing tables ... indicate that [DOE] would obtain data needed to distinguish among the credible alternative conceptual models supported by currently available data." The collection of additional data would be used to "to determine which [conceptual] models appear to be more viable..." and any revisions to current testing plans would be documented in the semiannual Yucca Mountain Project Status Reports.

- Based on these statements, it appears that DOE will investigate only those alternative conceptual models currently identified in the SCP hypothesis testing tables; this, despite the concern expressed in this comment that the hypothesis testing tables need to be revised because (1) the tables do not identify all the potentially important alternative conceptual models, and (2) the studies cited to provide the data required to distinguish between the current conceptual model and the stated alternative(s) do not always appear to do so.

- DOE did not respond to the NRC staff's concern that the hypothesis tables are not integrated across technical disciplines.

- The NRC staff considers this comment open.

Section 8.3 Planned Tests, Analyses, and Studies

SCA COMMENT 7

The clarified role of subjective methods (e.g., formal use of judgment) in site characterization has not been applied to all segments of site characterization to determine when it is best to use experts in the analysis itself and when it is best to call for peer review of investigations or judgments.

EVALUATION OF DOE RESPONSE

- This comment calls attention to the need for clearly distinguishing the role of expert judgment (a means to generate original work) and the role of peer review (an in-depth critique of original work) and using them appropriately. DOE cites the NRC staff position on peer review, NUREG-1297 (the citation given is NUREG-1298, but this is apparently a typographical error) in support of its distinction between expert judgment and peer review. NUREG-1297 defines a peer review in terms of it being a critique. However, the examples cited in the response leave DOE's interpretation somewhat ambiguous. Some discussion with DOE is needed to resolve this aspect of the comment.

- DOE repeats the same paragraph about preserving flexibility to define the level of judgment or review that was used in its response to Comment 3.

- The NRC staff considers that DOE has not demonstrated that analyses and models that will be used to predict future conditions and changes in the geologic setting will be supported by using an appropriate combination of such methods as field tests, in situ tests, laboratory tests which are representative of field conditions, monitoring data, and natural analogue studies.

- The NRC staff considers this comment open.

Section 8.3.1.17.12.2 Activity: Evaluate tectonic models

SCA COMMENT 8

Alternative tectonic models for the site do not appear to be fully integrated into the site characterization plan and as a result alternatives are apparently not considered in the preliminary performance allocations and the design of the Engineered Barrier System (EBS). The site characterization program appears to be directed toward providing data that confirm the preferred tectonic model rather than determining what the "preferred model" should be.

EVALUATION OF DOE RESPONSE

- There are nine basis points supporting this comment. It's response does not directly address most of those bases; rather, indicates that the concerns expressed are being addressed by two project tasks under development: (1) The Study Plan on Tectonic Models and Synthesis (8.3.1.17.4.12), and (2) The Testing Prioritization Task.
- Closure of this comment must await the completion and NRC staff evaluation of the referenced documents.
- The NRC staff considers this comment open.

Section 8.3.1.1, p. 8.3.1.1-6,7,8	Overview of the Site Program: Role of Alternative Conceptual Models
Tables 8.3.1.2-2a,b, 8.3.1.3-2, 8.3.1.4-2,...	Current Representative and Alternative Hypotheses...

SCA COMMENT 9

Expert Judgment used in developing the hypothesis testing tables does not appear to have been based on a consistent logic and thus may not be traceable and defensible.

EVALUATION OF DOE RESPONSE

- Although the subject of Comment 9 is Expert Judgment, DOE's response speaks only to the hypothesis testing tables. The point being made in Comment 9 is that the logical and factual basis for expert judgment used should be clear and well documented. The hypothesis testing tables are considered important as the basis for identifying alternate conceptual models.

- DOE's response to Comment 9 is a reference to its response to Comment 6. In its response to Comment 6, the DOE does not address the issue raised by this comment. The response to Comment 6, in turn, refers to DOE's response to Comment 1, which also does not address this comment.

- The NRC staff considers this comment open. Closure requires that DOE address the original comment and recommendation.

Section 8.3.1.2 Overview of the geohydrology program: Description of the present and expected geohydrologic characteristics required by the performance and design issues

SCA COMMENT 10

The technical basis for initial assessments of the significance of individual features, events and processes of the hydrologic system to performance measures or design or performance parameters is not discussed. In addition, some aspects of the current descriptions of the regional and site hydrogeologic systems are not well stated.

EVALUATION OF DOE RESPONSE

- In response to this comment DOE acknowledges "inconsistencies and ambiguities regarding performance modeling and the underlying assumptions, and how these are related to site characterization parameters, performance measures, design and performance parameters (performance allocation), and how the geohydrologic processes and events are to be tested as part of characterization" (page 43). Further, DOE indicates that despite its attempt to be as thorough as possible in the SCP, it is not a licensing document and the rigor of analyses that underpin the technical planning for a study program is not expected to be sufficient for a licensing process, and would not be capable of withstanding the degree of scrutiny in a Safety Analysis Report (SAR). DOE also indicates that as characterization proceeds, it intends to clarify the manner in which data gathered as part of the many hydrologic studies are to be used to build an SAR in support of a license application. DOE considers this an evolving process for which the direction of early planning is expected to be reconsidered, modified, and changed. This will be done "under a formal change-control process" and "technical reports that evolve from the site characterization program will explain variances in how the program for data acquisition and analysis, and performance modeling, have evolved from discussions in the SCP" (p. 44).

- Therefore, although DOE agrees that there are gaps in performance allocation logic and that ambiguous or inconsistent definitions are present in the SCP, the SCP will not be purged by a revision because "such errors would not be perpetuated" due to the fact that the program's technical support documentation (TSD), under the Project Office's Technical Support Documentation Management Plan (Rev. 0), provides a "self-correcting mechanism for documenting variances with the SCP" (p. 44). Further, "variances would be documented not only from the current technical program but also throughout the program's evolution as more information is gathered about the site" (p. 45).

- The NRC staff considers this comment open. The purpose of this comment was to stress the importance of identifying essential conceptual elements of the hydrologic system to provide a focus for site investigations, particularly for those elements significant to repository performance. It is not clear that DOE's Technical Support Documentation Management Plan alone would be a technically sufficient process to ensure correction of the deficiencies cited in this comment. However, DOE has provided in

response to SCA Comment 1 a discussion of a more complete process that addresses the iterative relationship among performance allocation, the site program, performance assessment, hypothesis (alternative conceptual model) testing, and issue resolution that may lead to correction of existing deficiencies.

- Closure of this comment is dependent upon NRC review of the documents referenced by DOE in its response to SCA Comment 1 and upon closure of SCA Comment 1.

Section 8.3.1.2 Overview of the geohydrology program: Description of the present and expected geohydrologic characteristics required by the performance and design issues

Section 8.3.2 Respository Program

Section 8.3.4 Waste Package Program

SCA COMMENT 11

There are no hypotheses presented about thermal effects on the hydrologic system caused by emplaced waste. As a result, it is unclear whether the limited testing program will be adequate to understand the response of the hydrologic system to the thermal load. Further, some information from the geohydrology program expected by other program areas cannot be provided.

EVALUATION OF DOE RESPONSE

- In response to this comment DOE acknowledges that "conceptual models in which repository heat adversely affects the unsaturated zone groundwater flow system are not included in the hypothesis testing tables in the Site Characterization Plan (SCP)" (p. 47) and acknowledges the error in Table 8.3.2.3-3 that references the geohydrology program as a source of information on thermal effects. DOE also makes note, in its response to the SCP comment, of two concerns expressed by the Nuclear Waste Technical Review Board (NWTRB). The two concerns expressed by the NWTRB are: (1) a higher temperature source term (heat load) makes calculations of performance more complex, adding to uncertainty in performance predictions, and (2) decreasing the heat load could allow waste canisters to be loaded more densely, decreasing total cost. DOE indicates that "The U.S. Nuclear Regulatory Commission and NWTRB concerns must be considered together because a decision with respect to one affects how the other can be addressed. For example, a decision to limit heat load to minimize technical uncertainties in near field interactions would also decrease the need to predict the effects that the heat would have on the unsaturated groundwater flow system. Conversely, a decision to increase canister loading density to decrease total system cost would require more rigorous calculations" (p. 48). DOE states that it is "currently deciding how to address" these concerns (p. 47).

- Although in its response DOE acknowledges that the hypothesis testing tables do not specifically include a conceptual model regarding thermal effects on the hydrologic system caused by waste emplacement and are currently deciding how to address concerns presented, DOE also indicates that the SCP and supporting study plans do provide for the collection of data and development of models required to address the SCA comment. Specifically, DOE references the following: (1) Repository design information need 1.11.6: repository thermal loading and predicted thermal and thermomechanical response of the host rock (SCP section 8.3.2.2.6) and (2) Information need 1.10.4: post-emplacement near-field environment (SCP section 8.3.4.2.4), particularly Study 1.10.4.2: hydrologic properties of waste package environment (SCP section 8.3.4.2.4.2) and Activity

1.10.4.4.1: repository horizon near field hydrologic properties (SCP section 8.3.4.2.4.4.1).

o The NRC staff has reviewed the DOE response including an additional review of referenced SCP material and has reached the following conclusions:

- DOE's conclusion that a decision to limit heat load to minimize technical uncertainties in near field interactions would also decrease the "need" to predict the effects that the heat would have on the unsaturated groundwater flow system may be of concern to the NRC staff. If DOE means that analyses may become simpler and the response smaller, the NRC staff would agree. However, if DOE means the analyses will not need to be done, the NRC staff notes the requirement indicated in 10 CFR 60.21(c)(1)(i)(F) wherein it is stated that the SAR shall include "the anticipated response of the geomechanical, hydrogeologic, and geochemical systems to the maximum design thermal loading, given the pattern of fractures and other discontinuities and the heat transfer properties of the rock mass and groundwater." It is this predictive analysis, to be provided in the SAR by DOE, that will provide the technical basis, at least in part, for demonstrating whether the response of the site geomechanical, hydrogeologic and geochemical systems to the heat load, in both the near and far field, will be material to the repository system and system components complying with the regulatory requirements of 10 CFR 60 (e.g., 10 CFR 60.112, 10 CFR 60.113, 10 CFR 60.133(i), 10 CFR 60.135(a)).

- DOE's planned activities under the repository and waste package programs will not provide a complete description of the anticipated response of the site hydrogeologic and geochemical systems to the maximum design thermal loading, as required by 10 CFR 60.21(c)(1)(i)(F), because planned analyses encompassing the far field scale will only consider processes related to the geomechanical system (e.g., thermomechanical effects). The bases for this conclusion are:

  1. Although planned analyses within the waste package program broadly consider physical processes related to the hydrogeologic, geochemical and geomechanical systems, the scale of planned analyses is limited to the near field (repository horizon).

  2. Although planned analyses within the repository program include cannister scale, drift scale, and far field scale analyses, the physical processes to be considered are limited to those related to the geomechanical system (e.g., thermomechanical effects). As noted previously, 10 CFR 60.21(c)(1)(i)(F) also requires evaluation of the hydrogeologic and geochemical systems. In addition, 10 CFR 60.21(c)(1)(i)(F) requires that the heat transfer properties of groundwater be considered as well as the heat transfer properties of the rock mass.

  3. There is information given in the SCP and elsewhere regarding the potential movement of moisture in Yucca Mountain due to

diurnal and seasonal changes in temperature and barometric pressure. Thus, considering this natural condition, the potential exists that heat-driven flow could induce fluid motion far from the location of the thermal gradients caused by emplaced waste.

- Without a complete description of the anticipated response of the site geomechanical, hydrogeologic and geochemical systems to the maximum design thermal loading it will be difficult for DOE to defend its decision not to consider the hydrogeology and geochemistry of the far field in its predictions of the post-emplacement repository environment; (predictions that will be used in the design and performance evaluation of the waste package and underground facility). In the demonstration of compliance with the performance objectives 10 CFR 60.112 and 10 CFR 60.113 (and all the other sections of 10 CFR 60 that refer to these paragraphs, such as 10 CFR 60.133(i)), the burden lies with DOE to demonstrate that the assumptions made and the considerations omitted from the analyses of performance have no substantial effect on the performance of the repository. With regard to movement of groundwater and the transport of radionuclides far from the repository, DOE needs to demonstrate that the heat from emplaced waste does not degrade repository performance below regulatory limits or, alternatively, must demonstrate by analyses, experiment, or a combination thereof, that heat loading is immaterial or has a benign effect on performance. Thus, there exists the potential for DOE's demonstration of compliance with the regulatory requirements of 10 CFR 60 (e.g., 10 CFR 60.112, 10 CFR 60.113, 10 CFR 60.133(i), 10 CFR 60.135(a)) provided in the SAR to be incomplete.

- Therefore, the NRC staff considers this comment open. While acknowledging the concerns expressed in this comment, DOE has not identified any specific actions or timeframe to resolve the comment. In the evaluation of the DOE response the staff has elaborated on and provided further discussion of the potential ramifications of what was essentially a comment on the apparent lack of plans to understand the response of the hydrologic system to the thermal load. In order to make progress toward resolution, the NRC staff will have to review future DOE SCP progress reports and evaluate program changes that reflect DOE plans with respect to: 1. Providing a complete description of the anticipated response of the geomechanical, hydrogeologic, and geochemical systems to the maximum design thermal loading, given the pattern of fractures and other discontinuities and the heat transfer properties of the rock mass and groundwater; 2. Considering the far field scale in the prediction of the post-emplacement near field environment when such predictions are used in the demonstration of compliance with 10 CFR 60.113 and 10 CFR 60.135(a); 3. Considering the far field hydrogeologic and geochemical systems in the prediction of the post-emplacement repository horizon environment when such predictions are used in the demonstration of compliance with 10 CFR 60.113 and 10 CFR 60.133(i); and 4. Considering completely the anticipated response of the geomechanical, hydrogeologic, and geochemical systems to the maximum design thermal loading, given the pattern of fractures and other discontinuities and the heat transfer properties of the rock mass and groundwater in the demonstration of compliance with 10 CFR 60.112.

Section 8.3.1.2 Overview of the geohydrology program: Description of the present and expected geohydrologic characteristics required by the performance and design issues

Section 8.3.1.2-2a Current representation and alternative hypotheses for unsaturated-zone hydrologic system conceptual models for the geohydrology program

SCA COMMENT 12

The hypothesis that liquid-water flow in the Calico Hills unit is restricted to the rock matrix and the hypothesis that matrix properties of the altered Calico Hills nonwelded zeolitized unit are probably largely isotropic (because chemical alteration can be expected to destroy preferred orientations of rock properties) are not stated in Table 8.3.1.2-2a and no definite activities to test them are found in the plan.

EVALUATION OF DOE RESPONSE

- The response does not focus on Comment 12 itself, but rather, a suggestion in the comment "Recommendation." A suggestion in the "Recommendation" of SCA Comment 12 states that "Testing the hypothesis that the matrix of the altered Calico Hills nonwelded zeolitized unit is largely isotropic, by using multiple well tests in the saturated zone, should be considered." The response points out that current plans call for testing the saturated zone of the Calico Hills unit in the UE-25c well complex. However, it is also pointed out that because of the expected contrast in permeabilities between the fractures and the matrix in the Calico Hills unit, DOE considers that the presence of fractures would thoroughly dominate the hydraulic response of any tests of the Calico Hills unit below the water table. The response implies that it is impractical to use multiple well tests in the saturated zone to test the hypothesis that the matrix of the altered Calico Hills nonwelded zeolitized unit is largely isotropic.

- The NRC staff is willing to accept this explanation; however, the response does not address Comment 12, but rather an NRC suggestion that DOE may wish to consider in addressing the comment. Comment 12 points out that the SCP does not identify test activities for two ground water flow hypotheses. These hypotheses are:

  1. Liquid-water flow in the Calico Hills unit is restricted to the rock matrix.

  2. Matrix properties of the altered Calico Hills nonwelded zeolitized unit are probably largely isotropic.

- DOE is currently considering alternatives for characterizing the hydrologic properties of the Calico Hills unit. Two studies were initiated by DOE to identify an optimal testing strategy to characterize those properties (Risk/Benefit Analysis of Alternative Strategies For Characterizing The Calico Hills Unit At Yucca Mountain and the Exploratory Shaft Facility Alternatives Study). The NRC staff concludes that in order to make progress towards closure of this comment the NRC staff will have

to review the reports resulting from those two studies, with emphasis on the identified optimal testing strategy. Thus, the NRC staff considers this comment is open.

Section 8.3.1.2.1.2	Study: Characterization of Runoff and Streamflow
Section 8.3.1.2.1.2.1	Activity: Surface-water Runoff Monitoring
Section 8.3.1.2.2.1	Study: Characterization of Unsaturated-zone Infiltration
Section 8.3.1.2.2.1.2	Activity: Evaluation of Natural Infiltration

SCA COMMENT 13

The stream flow, precipitation gage and micro-meteorological station locations for the site watershed study may need to be redistributed and increased to adequately support the studies of natural infiltration.

EVALUATION OF DOE RESPONSE

- The NRC staff recommended that DOE allow flexibility in the plans of Study 8.3.1.2.1.2 (Runoff and Streamflow) to relocate and expand the instrumentation of the site watersheds to adequately complement the activities of Study 8.3.1.2.2.1 (Unsaturated-zone Infiltration) and to begin the watershed studies as soon as possible.

- DOE responded that "options for expanding and improving the network of precipitation stations are currently being evaluated." The plans by DOE to evaluate the instrumentation for the site (above repository) infiltration studies responds to the NRC comment, and it is anticipated that the results of this evaluation of the runoff and rainfall instrumentation will be reported under the guidance provided in the Test and Evaluation Plan. DOE also responded that it plans to begin these studies as soon as possible and cited a comment in Study Plan 8.3.1.2.1.2 to support its commitment.

- The NRC staff considers this comment closed.

Section 8.3.1.2.2.3.2 Activity: Site Vertical Borehole Studies

SCA COMMENT 14

There are no plans to collect in situ hydrologic properties of the tuffaceous beds of the Calico Hills nonwelded unit in the northern and central areas of the site.

EVALUATION OF DOE RESPONSE

- DOE responded that the systematic drilling program now includes plans to collect in situ hydrologic data from six boreholes drilled to 100 m below the water table into the tuffaceous beds of the Calico Hills nonwelded unit in the northern and central areas of the site. In addition to these vertical boreholes, a vertical borehole is planned to be drilled (USW 42-14) near the existing USW UZ-1 borehole.

- Therefore, the NRC staff considers this comment closed.

Section 8.3.1.2.2.3.3 Activity: Solitario Canyon Horizontal Borehole Studies

SCA COMMENT 15

The Solitario Canyon Horizontal borehole activity is inadequate to discriminate between the hypotheses that faults are everywhere barriers to fluid flow in nonwelded tuff units or are everywhere conduits for liquid-water flow in nonwelded tuff units. Further, it is doubtful that this activity is adequate to discriminate between the hypotheses that faults are conduits or barriers to liquid water flow in welded tuff units, depending on ambient matrix saturation or alternatively, faults are everywhere conduits for liquid water flow in welded tuff units.

EVALUATION OF DOE RESPONSE

- The DOE response to Comment 15 agrees that the Solitario Canyon borehole activity will not collect data to fully test the hypotheses identified in the SCP (Table 8.3.1.2-2a). However, DOE infers that Study Plan 8.3.1.2.2.3 (Characterization of Percolation in the Unsaturated Zone -- Surface-Based Study) and 8.3.1.2.2.4.10 (Hydrologic Properties of Major Faults Encountered in Main Test Level of the ESF) will provide the empirical data for use in addressing the comment. Further, these data will be corroborated by data gathered from studies (unreferenced) that themselves are not expressly designed to address this question.

- In summary, DOE appears to agree that the hypotheses will not be tested solely based on the Solitario Canyon Horizontal Borehole activity as referenced in the SCP, and infers that it will be accomplished through tests conducted under other study plans. In order to make progress towards resolution of this comment, the NRC staff will have to review the two referenced study plans and other study plans yet to be specified by DOE. Thus, the NRC staff considers this comment open.

Section 8.3.1.2.2.4.6 Activity: Calico Hills Test in the Exploratory Shaft Facility

Section 8.4.2.1.6.1 Characterization of the Calico Hills Nonwelded Unit

SCP COMMENT 16

The SCP does not contain a plan to adequately characterize the hydrologic properties of the Calico Hills unit, which has been designated the primary barrier to ground water flow and radionuclide transport.

EVALUATION OF DOE RESPONSE

- Studies were initiated by DOE to identify an optimal testing strategy to characterize the hydrologic properties of the Calico Hills unit (Risk/Benefit Analysis of Alternative Strategies For Characterizing The Calico Hills Unit At Yucca Mountain and the Exploratory Shaft Facility Alternatives Study). Comment 16 was primarily focused on the need to understand the effects that fractures and faults have on flow paths and travel times, and the conditions under which fracture flow may occur in the Calico Hills unit. The response states that considerable weight was given to a testing strategy that would confirm or reject the hypothesis that water movement in the Calico Hills nonwelded unit has a predominantly vertical component of flow through the matrix and continues downward directly to the water table wherever it intersects the Calico Hills nonwelded unit.

- In summary, DOE agrees that plans are needed to characterize the hydrologic properties of the Calico Hills unit and that they are presently considering different strategies to collect the needed information. The staff concludes that in order to make progress towards resolution of this comment, it will have to review the Risk/Benefit Analysis of Alternative Strategies For Characterizing The Calico Hills Unit At Yucca Mountain and the Exploratory Shaft Facility Alternatives Study with emphasis on the identified optimal testing strategy. Thus, the NRC staff considers this comment open.

Section 8.3.1.2.2.4.9 Activity: Multipurpose-borehole testing near the exploratory shafts

SCA COMMENT 17

No plan for sampling and analyzing pore and fracture fluids from rock core samples in order to detect the possible presence of the LiBr tracer used to identify drilling fluid from USW G-4 is included in the activity on multipurpose-borehole testing near the exploratory shafts.

EVALUATION OF DOE RESPONSE

- The NRC staff had recommended that the multipurpose-boreholes be added to the group of wells to be sampled under the activity of aqueous-phase chemical investigations. DOE responded that study 8.3.1.2.2.7 specifies the collection of core samples from the multipurpose boreholes for hydrochemical analysis. Approximately 10% of the total footage cored will be sampled. Specifically, as stated in study plan 8.3.1.2.2.7 (DOE, 1989), multipurpose boreholes USW MP-1 and MP-2 will be used for both gaseous-phase and aqueous-phase sampling. The aqueous-phase sampling involves the extraction of pore water from core samples.

- In summary, the NRC staff considers this comment closed.

REFERENCE

DOE, 1989. Study Plan "Hydrochemical Characterization of the Unsaturated Zone": YMP-USGS-SP 8.3.1.2.2.7, R0, U.S. Dept. of Energy.

Section 8.3.1.2.2.9.3 Activity: Simulation of the natural hydrogeologic system

Section 8.3.1.2.3.3.2 Activity: Development of a fracture network model

Section 8.3.1.2.3.3.3 Activity: Calculation of flow paths, fluxes, and velocities within the saturated zone to the accessible environment

SCA COMMENT 18

Technical issues to be addressed by these activities represent only a partial consideration of all features, events or processes that may be essential for a valid mathematical representation of the hydrogeologic system for use in performance assessment analyses. As a consequence, planned activities are insufficient to provide technical justification for initial modeling strategies.

EVALUATION OF DOE RESPONSE

- In response to this comment DOE indicates that periodic progress and status reports will be issued to formally notify the performance assessment program about the evolution of the conceptual model and the appropriateness of prevailing data-acquisition and experimental work. Further, DOE indicates that plans such as these should be refined based on new data, rather than continue to re-plan the testing program absent new data.

- The NRC staff considers this comment open. The point of this comment is that the program for model development needs to systematically consider all of the essential conceptual elements of the site hydrologic system so as to allow, ultimately, DOE's performance assessment program to identify and demonstrate that the assumptions made and the considerations omitted from analyses of performance have no substantial effect on the performance of the repository. Issuing progress and status reports to the performance assessment program is not sufficient to address this comment. DOE has provided in response to SCA Comment 1 a discussion of a more complete process that addresses the iterative relationship among performance allocation, the site program, performance assessment, hypothesis (alternative conceptual model) testing, and issue resolution that may lead to correction of program deficiencies. However, resolution of this comment is dependent upon NRC review of the documents referenced by DOE in their response to Comment 1 and the closure of Comment 1.

Section 8.3.1.2.3.1	Study: Characterization of the site saturated-zone groundwater flow system
Section 8.3.1.2.3.1.1	Activity: Solitario Canyon fault study in the saturated zone
Section 8.3.1.2.3.1.3	Activity: Analysis of single- and multiple-well hydraulic-stress tests
Section 8.3.1.2.3.1.4	Activity: Multiple-well interference testing

SCA COMMENT 19

Activities presented for the study of the saturated zone flow system are not adequate to characterize saturated zone hydrologic boundaries, flow directions and magnitudes, and flow paths.

EVALUATION OF DOE RESPONSE

- DOE has acknowledged that the SCP contains a limited scope for planned testing in the saturated zone. This limited scope was based on three considerations: (1) the saturated zone is currently only a secondary barrier; (2) there remains considerable uncertainty about whether single-well or multiple-well hydraulic tests will yield interpretable results; and (3) plans for site-scale saturated zone studies will evolve as data are gained from other studies and new data needs are recognized.

- DOE recognizes that a more thorough characterization of the site saturated zone may be needed to support related investigations, regardless of whether a high level of confidence is needed for the solute-transport characteristics of the saturated zone barrier. DOE agrees that additional work may be needed to characterize the saturated zone, but defers identifying those activities until data needs are clarified. DOE considers that data from work already planned will be needed to effectively plan further work.

- DOE acknowledges that additional well complexes similar to the C-hole (UE-25c) site will likely be needed. Possible locations for new well complexes include Solitario Canyon, Dune Wash, and southwestern Midway Valley. These and other locations will be considered if new well-cluster tests are needed. Two large-scale pumping tests are currently planned, including one at the C-hole site and one at the proposed well USW H-7. Both tests will be conducted at large rates of withdrawal for up to 30 days. If additional multiple-well sites are developed, they may be pumped for longer periods than the 3 to 5 days mentioned in the SCP.

- The Solitario Canyon fault study was designed to test whether the fault is a barrier to eastward flow, thereby causing the moderately large hydraulic gradient in the area. DOE concludes that direct testing below the water table may also be needed to assess the hydraulic characteristics of this fault.

- DOE agrees that the planned saturated zone studies may need to be re-evaluated after new testing data are obtained from other studies. DOE concluded that neither the design nor the start of expanded studies in the saturated zone is warranted at this time. Still, the NRC staff has concerns about whether the site characterization program as designed will obtain adequate information about aquifer coefficients in the saturated zone, especially effective porosity. The NRC staff recognizes that effective porosity may be the most difficult aquifer coefficient to obtain, particularly in a flow regime where fractures may dominate groundwater flow. Effective porosity is typically estimated from values of "effective thickness," as derived from multi-well field tests. Single-well tests cannot reliably produce representative values of effective porosity at appropriate scales. Overall, it is not clear how DOE can adequately characterize effective porosity within the controlled area downgradient from the repository using only one multi-well testing site (C-hole site) and limited-scale, single-well tests.

- With respect to single-well vs. multiple-well testing, DOE responded that, although multiple-well tests probably will be more useful than single-well tests, this cannot be decided until the detailed testing program at the UE-25c well cluster is underway and partly interpreted. However, the NRC staff is aware that preliminary testing was conducted at the UE-25c cluster in the mid-1980's. According to Fenix & Scisson (1986), numerous hydrologic tests, including packer, drawdown, and tracer tests, were conducted during 1984 and 1985. The preliminary evaluations of the data from these tests have not been formally published, but were sent to NRC attached to a letter from DOE (DOE, 1990). Other preliminary tests have been conducted at the multi-well site of UE-25a#1 and UE-25b#1, and the results are given in the SCP.

- The NRC staff considers this comment open. DOE's commitment to re-evaluate data needs after initial testing data are obtained does not in itself resolve this comment. Based on preliminary testing conducted at the UE-25c cluster in the mid-1980's, sufficient hydrologic data should already exist for DOE to start planning additional studies in the saturated zone. Planning should begin immediately by DOE to ensure that sufficient numbers of aquifer tests will be performed at appropriate scales to adequately support performance assessment calculations. This planning is important if DOE reasonably expects that a high level of confidence will be needed in the solute-transport characteristics of the saturated zone barrier.

REFERENCES

DOE, 1990. Letter to John J. Linehan from Carl P. Gertz, September 26, 1990, Subject: Transmittal of References for Study Plan 8.3.1.2.3.1.7, "Testing of the C-Holes with Reactive Tracers."

DOE, 1991. Study Plan "Characterization of the Site Saturated-Zone Ground-Water Flow System": YMP-USGS-SP 8.3.1.2.3.1 R0, U.S. Dept. of Energy.

Fenix & Scisson, Inc., 1986. NNWSI Hole Histories, DOE/NV/10322-14, U.S. Dept. of Energy.

Section 8.3.1.2.3.1.2 Activity: Site potentiometric-level evaluation

Figures 3.28 and 8.3.1.2-21 Preliminary composite potentiometric surface map of the saturated zone

SCA COMMENT 20

The potentiometric surface in the controlled area is not adequately defined by existing well locations, and will not be adequately defined by proposed additional well sites.

EVALUATION OF DOE RESPONSE

- DOE responded to NRC's concerns about the adequacy of the well network to characterize the potentiometric surface. The response addressed both the southern and northern portions of the controlled area. The southern area refers to an area of over 12 square km south of wells WT-1 and G-3 and east of well WT-10. The northern area refers to the zone of a large southeastward hydraulic gradient located north of the site between wells G-1 and G-2.

- Southern area: DOE noted that the 12 square km area is topographically rough, with only limited locations for new wells. However, DOE acknowledges that for this area there is uncertainty about: (1) the configuration of the potentiometric gradient; and (2) the influence of faults on directions and pathways of groundwater flow. These factors may justify a more comprehensive study of the saturated zone. However, DOE has chosen to defer identifying additional activities until data needs are clarified.

- Northern area: In the SCP, three new wells (USW WT-9, -23, and -24) were planned to better define the large southeastward hydraulic gradient that occurs north of the site. In addition to these wells, DOE plans to drill USW UZ-14 into the upper part of the saturated zone. This is a change from SCP Table 8.3.1.2-7, which showed that this well would terminate in the Topopah Spring Member of the Paintbrush Tuff. DOE also considers that USW UZ-14 will directly investigate the actual water-table altitude at USW UZ-1.

- At present, the location for UZ-14 has not been finalized by DOE. As shown in SCP figure 8.3.1.2-14, the proposed location for UZ-14 was southeast of UZ-1 in Drill Hole Wash, close to the existing well USW G-1. In the SCP figure, a question mark appears beside the well to show that its location is tentative. A different location for UZ-14 is shown in the study plan titled "Hydrochemical Characterization of the Unsaturated Zone" (DOE, 1989). Based on Figure 1.2-3 of this study plan, UZ-14 will be located just northwest of UZ-1. This location for UZ-14 is more appropriate for investigating the water table altitude than the preliminary location shown in the SCP.

- One objective of drilling UZ-14 is to investigate the large hydraulic gradient that exists between wells USW G-1 and G-2. If UZ-1 actually encountered the water table, then most of the head difference actually occurs between this well and well G-1, and the hydraulic gradient would be

much steeper than suggested by the potentiometric map on page 3-149 of the SCP.

- If the groundwater at the bottom of UZ-1 is actually perched water, it would demonstrate that some portions of the unsaturated zone do not drain freely. Perched groundwater, if present, may be natural in origin, or may be localized saturation derived from drilling fluid lost during the construction of nearby well G-1, which was completed in 1980. According to Whitfield (1985), the first 58 ft of this hole were drilled in alluvium using 1200 gallons of water tagged with a lithium bromide tracer. Altogether, approximately 2.3 million gallons of drilling fluid were lost in the drilling and coring of well G-1. According to Whitfield (1985), water samples collected from well UZ-1 are contaminated with the drilling polymer that was used to drill well G-1. The contamination detected in well UZ-1 had traveled about 300 m from G-1 in less than three years. Whitfield (1985) concluded that a major fracture zone probably provides hydraulic communication between G-1 and UZ-1.

- The NRC staff considers SCA comment 20 to be open. In summary, DOE agrees that additional drilling and testing are needed in the northern area to characterize the zone of large hydraulic gradient. However, for the southern area (south of wells G-3 and WT-1 and east of WT-10) DOE has chosen to defer identifying additional activities until data needs are defined. The NRC staff concludes that the commitment by DOE to consider additional testing does not in itself resolve this comment. The NRC staff still considers that additional wells will be needed in the controlled area south of wells G-3 and WT-1 and east of WT-10. These additional wells would help to adequately characterize the potentiometric surface in that area. In order to make progress toward resolution, NRC will have to review DOE (1991) and evaluate data needs identified by DOE.

REFERENCES

DOE, 1989. Study Plan "Hydrochemical Characterization of the Unsaturated Zone": YMP-USGS-SP 8.3.1.2.2.7, R0, U.S. Dept. of Energy.

DOE, 1991. Study Plan "Characterization of the Site Saturated-Zone Ground Water Flow System": YMP-USGS-SP 8.3.1.2.3.1 R0, U.S. Dept. of Energy.

Whitfield, M. S., 1985. Vacuum Drilling of Unsaturated Tuffs at a Potential Radioactive-Waste Repository, Yucca Mountain, Nevada: Proceedings of NWWA conference on Characterization and Monitoring of the Vadose (Unsaturated) Zone, National Water Well Association, November.

Section 8.3.1.2.3.2	Study: Characterization of the saturated zone hydrochemistry
Section 8.3.1.2.3.2.1	Activity: Assessment of saturated-zone hydrochemical data availability and needs
Section 8.3.1.2.3.2.2	Activity: Hydrochemical characterization of water in the upper part of the saturated zone
Section 8.3.1.2.3.2.3	Activity: Regional hydrochemical characterization

SCA COMMENT 21

Technetium-99 and iodine-129 are not explicitly included in studies to characterize groundwater flow and radionuclide background concentrations in groundwater.

EVALUATION OF DOE RESPONSE

- NRC had previously recommended that technetium-99 and iodine-129 be added to the group of radioisotopes that will be analyzed from water samples collected in the upper part of the saturated zone and in any discovered zones of perched groundwater.

- DOE responded that these data will be collected under the Radiological Monitoring Plan (DOE, 1988) rather than the Site Characterization Plan. DOE plans to analyze 10-15 percent of samples acquired by the saturated zone hydrochemistry study for Tc-99 and I-129. Additional analyses will be done if initial data show them to be appropriate. The study plan for saturated zone hydrochemistry (8.3.1.2.3.2) will address the cooperative sampling.

- DOE's response does not adequately address the NRC comment. A key part of NRC's comment was that analyses of Tc-99 and I-129 at the water table and in perched zones may provide insight about groundwater travel time and rates of migration of these radioisotopes in the vadose zone. Both I-129 and Tc-99 are among those radioisotopes for which release limits are specified in Appendix A of EPA's high-level waste standards (EPA, 1985). Data on migration of anthropogenic radioisotopes, including tritium and long-lived radioisotopes like Tc-99, I-129, and Cl-36, will provide important insight about groundwater flow paths and groundwater travel time. These data may provide a tool for the validation of numerical flow and transport models in the vadose and saturated zones.

- The DOE response does not address sampling from perched zones above the water table, and it is not clear that the radiological monitoring program will target perched groundwater for sampling. Any perched groundwater that is discovered during site drilling operations may be transient in nature, and thus perched water should be sampled as it is found. Accordingly, such sampling may have to be done as part of the site characterization program, rather than under the long-term radiological monitoring program.

- The NRC staff considers this comment open. DOE agrees that data on Tc-99 and I-129 need to be collected. However, DOE has planned to collect data

for these radioisotopes under the radiological monitoring program. The staff concludes that DOE's commitment to collect this data through the radiological monitoring program does not in itself resolve the comment. In order to make progress toward resolution, the NRC staff will have to review DOE's Radiological Monitoring Plan (DOE, 1988) and relevant study plans. Relevant study plans include DOE (1989) and plans under the following studies: Unsaturated-Zone Infiltration, Water Movement Tracer Tests, Percolation in the Unsaturated Zone, and Saturated Zone Hydrochemistry.

REFERENCES

DOE (U.S. Dept. of Energy), 1988. Radiological Monitoring Plan, DOE/NV-10576-6, Yucca Mountain Project Office, Las Vegas, NV.

DOE, 1989. Study Plan "Hydrochemical Characterization of the Unsaturated Zone": YMP-USGS-SP 8.3.1.2.2.7 R0, U.S. Dept. of Energy.

EPA (Environmental Protection Agency), 1985. Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes: 40 CFR Part 191, 50 FR 38066, Sep. 19, 1985.

Section 8.3.1.2.3.2.2 Activity: Hydrochemical characterization of water in the upper part of the saturated zone

SCA COMMENT 22

Use of packers to isolate saturated zone intervals for water sample collection has the potential to compromise sample collection.

EVALUATION OF DOE RESPONSE

- DOE responded that various methods will be used to provide the hydrologic isolation of borehole intervals for groundwater sampling. Borehole logging techniques will be used to select smooth borehole lengths where packers of sufficient length can attain adequate seals. During sampling, vertical isolation can be tested by monitoring heads below, within, and above the sampled intervals. Sensitive differential-pressure transducers will be used to detect and monitor perturbations in head.

- DOE's intended approach is to drill wells to total depth and then install packers and sampling devices. The sampling procedure described for fully drilled wells appears reasonable for wells that already exist, but does not allow for sampling from perched zones that may be encountered during the drilling of new wells. Perched zones that may be penetrated will drain downward via the borehole, resulting in hydrochemical mixing at the water table and the possible loss of the chance to sample the perched water. For this reason, the first significant water-producing zone that is encountered should be sampled for hydrochemical and radioisotopic analyses. Such an approach will ensure that all significant perched zones will be sampled during drilling operations.

- DOE should be prepared to sample any perched groundwater zones that are encountered during site drilling operations. Perched groundwater should be analyzed for anthropogenic contaminants, including radioisotopes like tritium, iodine-129, chlorine-36, and technetium-99, because the presence of these contaminants deep in the vadose zone would suggest conditions of enhanced infiltration and rapid percolation.

- The NRC staff considers this comment open. In summary, DOE agrees that hydrologic isolation of borehole intervals during groundwater sampling is important. DOE will attempt to collect discrete samples under study plan 8.3.1.2.1.3 (Characterization of the Regional Groundwater Flow System) (DOE, 1990) and study plan 8.3.1.2.3.2 (Characterization of the Saturated Zone Hydrochemistry). The NRC staff concludes that DOE's commitment to collect discrete samples does not in itself resolve this comment. In order to make progress toward resolution, the NRC staff will need to review study plan 8.3.1.2.3.2 (Characterization of the Saturated Zone Hydrochemistry) and other documents that may be relevant to the sampling of perched groundwater (for example, plans for tracer tests, and the study plan for hydrochemical characterization of unsaturated zone).

REFERENCE

DOE, 1990. Study Plan "Characterization of the Yucca Mountain Regional Ground-Water Flow System": YMP-USGS-SP 8.3.1.2.1.3 R0, U.S. Dept. of Energy.

Section 8.3.1.3 Overview of the geochemistry program: Description of the present and expected geochemical characteristics required by the performance and design issues

SCA COMMENT 23

The geochemistry program does not plan to study the potential process of concentrating radionuclides on fracture surfaces and subsequent episodic transport.

EVALUATION OF DOE RESPONSE

- The NRC staff recommended that the SCP should include plans to evaluate processes and conditions that could result in concentrating radionuclides on fractures with subsequent episodic transport. DOE responded by stating that it will test the proposed scenario through modeling efforts. Also, data from Study 8.3.1.3.2.2 (History of Mineralogic and Geochemical Alteration of Yucca Mountain) and the natural isotope studies (i.e., Cl-36, U/Th disequilibrium) may provide evidence about whether this transport scenario may have occurred in the past.

- The NRC staff considers this comment closed.

Section 8.3.1.3.3.2.2 Activity: Determination of end-member free energies for clinoptililite-heulandite, albite, and analcime

Section 8.3.1.3.3.2.3 Activity: Solid solution descriptions of clinoptilolite-heulandite and analcime

SCA COMMENT 24

Standard solubility approaches are not sufficient for determining reliable thermodynamic properties of zeolites.

EVALUATION OF DOE RESPONSE

- The NRC staff recommended that DOE plan additional activities to determine the thermodynamic properties of zeolites for input to models. DOE responded by stating it believes the precision of the data from solubility experiments will be adequate to model mineralogic alteration at Yucca Mountain. Furthermore, the data will be evaluated after the experiments, and if it is determined that the precision is not adequate, the experimental program will be re-evaluated to ensure that data of sufficient precision are obtained. The NRC staff considers that in addition to evaluating the adequacy of thermodynamic data based on its precision, it is also necessary to evaluate that data with regard to its accuracy. Finally, more detail of the approach and methodology is to be included in the Study Plan (8.3.1.3.3.2, Kinetics and Thermodynamics of Mineral Evolution).

- The NRC staff considers this comment open. DOE does not agree that additional activities need to be planned at this time to determine the thermodynamic properties of zeolites for input into models. However, DOE indicates that data needs will be re-evaluated as test data are obtained. The NRC staff concludes that the commitment by DOE to reevaluate data needs does not in itself resolve this comment. In order to make progress towards resolution, the NRC staff will have to review Study Plan 8.3.1.3.3.2 (Kinetics and thermodynamics of mineral evolution).

Section 8.3.1.3.4 Investigation: Studies to provide the information required on radionuclide retardation by sorption processes along flow paths to the accessible environment

SCA COMMENT 25

The SCP does not provide the rationale for deciding on additional testing to obtain information on the effects of waste package degradation products and the interactions between and among radionuclides on sorption.

EVALUATION OF DOE RESPONSE

- The NRC staff recommended that DOE provide the rationale to be used in deciding on the need for additional testing using solutions containing waste package degradation products and for additional testing to measure the effects of competition and interaction between and among radionuclides. DOE responded to the first part of this comment by directing attention to studies whose purpose is to identify waste package degradation products. For example, Activities 8.3.4.2.4.1.2 (Effect of grout, concrete, and other repository materials on water composition) and 8.3.4.2.4.1.6 (Effects of container and borehole liner corrosion products on water chemistry) of Study Plan 8.3.4.2.4.1 (Characterization of Chemical and Mineralogical Changes in the Post-emplacement Environment) will be designed to identify waste package degradation products when the waste package materials are selected. DOE did not respond specifically to the second part of the comment dealing with interactions between and among radionuclides. However, the sorption study plan would be revised as more data on the degradation products is obtained.

- The NRC staff considers this comment open. In summary, DOE agrees that sorption testing using solutions containing waste package degradation products needs to be done. The DOE is to collect this information on degradation products in Study Plan 8.3.4.2.4.1 (Characterization of Chemical and Mineralogical Changes in Post-Emplacement Environment), and the Sorption Study Plan (8.3.1.3.4.1) will be revised as needed. The NRC staff concludes that the commitment by DOE to collect waste package degradation product information and to consider additional testing does not in itself resolve this comment. In order to make progress towards resolution, the NRC staff will have to review the referenced study plans.

Section 8.3.1.3.4.1 Study: Batch Sorption Studies

SCA COMMENT 26

Evidence presented is not adequate to conclude that existing sorption characterization data for alkali and alkaline earth elements are sufficient for performance assessment analyses. As a result, data collection plans are not complete.

EVALUATION OF DOE RESPONSE

- DOE agrees with the comment and indicates that further data acquisition for alkali and alkaline earth elements are included in the description of information to be collected in SCP Section 8.3.1.3.4.1. The NRC staff considers this comment closed.

Section 8.3.1.3.4.1.1 Activity: Batch sorption measurements as a function of solid phase composition

SCA COMMENT 27

Planned experimental batch sorption tests involving pure minerals cannot result in a mechanistic understanding (i.e., differentiation of surface complexation and ion exchange) of sorptive processes.

EVALUATION OF DOE RESPONSE

- The NRC staff recommended that DOE correct the inconsistency so that a mechanistic understanding is obtainable. DOE responded to the comment by explaining that footnotes for Table 8.3.1.3-3 are incorrect and inconsistent with statements made in the text. These footnotes had stated the "tests will be run at only one concentration". Instead, DOE states that isotherms will be determined using a minimum of eight different concentrations. Thus, the inconsistency is corrected and the NRC staff considers this comment closed.

Section 8.3.1.3.4.1.4 Activity: Sorption on particulates and colloids

Section 8.3.1.3.5.2.1 Activity: Colloid formation characterization and stability

SCA COMMENT 28

The SCP does not include studies to evaluate the effects of colloid formation due to stable (non-radioactive) elements formed from anthropogenic sources such as corrosion of the waste canisters, and organic compounds from drilling muds and explosives used in site construction.

EVALUATION OF DOE RESPONSE

- The NRC staff recommended that the SCP should include plans to study the effect of anthropogenic colloids on transport of radionuclides. The DOE responded to this comment by describing a multiphase approach to address the questions of colloid formation, their interactions with radionuclides, and their transport away from the near field. Initial studies will be used to determine if a long complex experimental program is needed or if the magnitude of the potentially adverse effects is sufficiently small that a less elaborate experimental progam is appropriate.

- Study Plan 8.3.4.2.4.1 (Characterize the Chemical and Mineralogical Changes in the Post-Emplacement Environment) has two activities 8.3.4.2.4.1.2 (Effect of grout, concrete, and other repository materials) and 8.3.4.2.4.1.6 (Effects of container and borehole liner corrosion products on water chemistry) which are intended to identify colloids, corrosion products, and organics.

- How these materials will affect radionuclide transport will be studied in 8.3.1.3.6.1; Dynamic Transport Column Experiments and 8.3.1.3.4.1: Batch Sorption Studies. From the results of these studies the need to perform additional work to address the question on the effect of colloids on radionuclide migration would be assessed and further work planned if necessary to resolve the question.

- The NRC considers this comment closed. In summary, DOE agrees that colloids need to be investigated and references three study plans as the source for the needed information.

Section 8.3.1.3.4.2 Study: Biological Sorption and Transport

SCA COMMENT 29

Activities to evaluate the effects of radioactive decay heat, the nuclear radiation field, and the effect of non site-specific microorganisms (introduced during site construction) on microbial activity and ecology, and the subsequent effects of these microbial processes on the groundwater chemistry, mineralogy, biogeochemical cycling and transport of high-level radioactive waste radionuclides are not included in the SCP. As a result, there is no way to evaluate the adequacy of this aspect of the DOE program.

EVALUATION OF DOE RESPONSE

- The NRC staff recommended that the SCP include plans to evaluate the effect of the waste package environment on microorganisms and their subsequent effect on groundwater chemistry, mineral stability, and radionuclide transport. DOE responded by stating it has already examined the biodegradation of drilling fluids and compiled an inventory of the fluids that will be used at the site. Microbial studies are being planned for the near-field environment and will be discussed in Study 8.3.4.2.4.1 (Characterization of Chemical and Mineralogical Changes in the Post-Emplacement Environment).

- The NRC staff considers this comment closed. DOE agrees that the effects of microorganisms introduced into the repository environment during construction and operation needs to be investigated, and references study plan 8.3.4.2.4.1 (Characterization of Chemical and Mineralogical Changes in the Post-Emplacement Environment) as the source for the needed information.

Section 8.3.1.3.5.1.3 Activity: Solubility Modeling

SCA COMMENT 30

The methodology and procedures for evaluating existing thermodynamic data that are to be used in solubility modeling are not included in the SCP and, thus, the adequacy of this activity cannot be evaluated.

EVALUATION OF DOE RESPONSE

- The NRC staff recommended that DOE develop and describe the methodology and procedures for evaluating existing thermodynamic data that are to be used in solubility modeling. DOE responded by stating it is currently developing the solubility modeling activity to be part of Study Plan 8.3.1.3.5.1 (Dissolved Species Concentration Limits). The Office of Civilian Radioactive Waste Management (OCRWM) participates in the NEA Thermodynamic Data Base (TDB) Project which is reviewing published thermodynamic data for species containing U, Pu, Am, Tc, and Np. This project will produce a set of thermodynamic data which are peer reviewed, internally consistent and supported by a compilation of data from literature. This data set will be incorporated into the EQ3/6 data base which, in turn, will be upgraded to be as complete as possible and internally consistent. Inadequacies in the data will be identified so that data gaps can be filled.

- The NRC staff considers this comment closed. In summary, DOE acknowledges the comment and states that NRC concerns will be evaluated during preparation of the study plan.

Section 8.3.1.3.6 Investigation: Studies to provide the information required on radionuclide retardation by dispersive, diffusive, and advective transport processes along flow paths to the accessible environment

SCA COMMENT 31

The determination of some parameters and conditions, such as speciation, kinetics, and matrix diffusion under fracture-flow conditions are not planned.

EVALUATION OF DOE RESPONSE

- The premise of the comment was that because fractures might contain minerals different from those found in the matrix, the determination of speciation, and kinetics involving matrix minerals may not be applicable to conditions in fractures. Furthermore, the Investigation is supposed to provide an empirical parameter measuring the effective diffusivity of the matrix-fracture interface. But, matrix diffusion experiments will not involve advection in fractures, nor actual matrix-fracture interfaces. The physical and chemical characteristics of this interface, however, could significantly affect the diffusion process.

- DOE responded to the comment by stating that fracture flow experiments will be used to validate models describing transport in fractures. This validation exercise is iterative in nature. Fracture transport experiments are performed to test models, whereupon the results of these tests drive the next set of experiments. Once a set of validated models for transport through fractures is obtained, it will be used to determine the most important scenarios for radionuclide fracture migration. These scenarios are then experimentally tested.

- For the parameters mentioned in the comment as not being collected under fracture-flow conditions, DOE states that those parameters will be determined. However, Table 8.3.1.3-7 of the SCP (p. 8.3.1.3-98) lists that the "effect (of, for example, speciation, kinetics, and matrix diffusion on radionuclide retardation) will be observed (in the fractured tuff column experiments), but parameter will be fit or derived from other experiment." The DOE response to the comment uses the phrase "effective parameters like those measured in fracture studies."

- The NRC staff considers this comment open. In summary, DOE suggests that the NRC concerns will be adequately addressed in Study Plan 8.3.1.3.6.1 (Dynamic Transport Column Experiments). However, for the parameters mentioned in the comment, it is still unclear to the NRC staff what parameters will be measured in fracture studies and how they will be measured. To make progress towards closure, the NRC staff will have to review the referenced study plan.

Section 8.3.1.4 Overview of the rock characteristics program: Description of the present and expected rock characteristics required by performance and design issues

Section 8.3.1.17 Overview of the preclosure tectonics: Description of tectonic and igneous events required by performance and design requirements

SCA COMMENT 32

The program for geophysical integration as presented in the SCP is insufficiently described. The correlation between the different geophysical investigations is not presented and, in addition, the approach that will be used to integrate the geophysical activities and how these different activities will complement each other does not appear to be discussed in the SCP.

EVALUATION OF DOE RESPONSE

- DOE in its response states "The concern about an insufficiently described integrated geophysical program..., has been addressed by the preparation of a geophysics 'White Paper'" (DOE, 1990). The response continues to state "This report is intended to serve as the basis for implementing an integrated geophysical program during site characterization (SCP Activity (sic) 8.3.1.4.1.2, Integration of Geophysical Activities)."

- DOE did not provide the results of the integrated interpretations of available existing geophysical data in the "White Paper."

- DOE indicated that when planned feasibility tests and initial data collection activities have been performed and evaluated, a comprehensive, coherent, and balanced geophysical program can be implemented.

- Resolution of this comment must await evaluation of DOE's Study Plan 8.3.1.4.1.2 and any other study plans relevant to this activity.

- The NRC staff considers this comment open.

REFERENCE

DOE, 1990, "White Paper," Status of Data, Major Results, and Plans for Geophysical Activities, Yucca Mountain Project. Yucca Mountain Project. YMP/90-38, U.S. Department of Energy, Las Vegas, Nevada, 1990.

Section 8.3.1.4 Overview of the Rock Characteristics Program, page 8.3.1.4-1/24

SCA 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 DOE's submittal of the above-mentioned study plans so that the NRC staff can determine 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 this comment open.

Section 8.3.1.4.1.1 Activity: Development of an integrated drilling program

Section 8.3.1.4.2.1 Study: Characterization of the vertical and lateral distribution of stratigraphic units within the site area

SCA COMMENT 34

Discussions of the integrated drilling program are unclear as to how data from various holes will be used in support of different studies; how uncertainty in core retrieval and data analysis will be handled; and how the large volume of existing information will be used to plan the drilling program.

EVALUATION OF DOE RESPONSE

- Although DOE appears to be well aware of the value of a thoroughly integrated drilling program it has not presented a convincing argument demonstrating the complex inter-dependence of data acquired under one study plan effort and the uses that will be made of the same data in the conduct and accomplishment of other study plans.

- As demonstration of the degree of integration of the drilling program DOE cites the geophysics "White Paper" (see Oliver and others, 1990) which includes Figure 3.2-1 depicting a matrix correlating categories of geophysical methods as well as identifying related surface-based boreholes.

- The above "White Paper" Figure 3.2-1 and supporting text do not appear to identify individual drilling examples representing a complete list of those studies requiring surface-based drilling. Lacking confirmation from DOE, the staff is unable to properly evaluate DOE's response to this portion of the subject SCA comment.

- The geophysics "White Paper" example cited as illustrative of the integration of information derived from the drilling program does not appear to be comprehensive at least from the drilling perspective.

- The NRC staff's impression of the "White Paper" matrix figure from the drilling aspect is that it is incomplete. For instance, it seems unlikely that the majority of the faulting-related study plans identified on the matrix (Figure 3.2-1) would not include the use of structural information obtained from boreholes penetrating faulted intervals.

- DOE indicates that information derived from multiple sources (e.g., shaft and drift excavations, outcrops and cleared pavement studies) will supplement data derived from drill holes.

- DOE indicates that angled drill holes are presently being proposed or being considered as an option in two instances-the Calico Hills Risk/Benefit Analysis and at the C-Hole complex.

- DOE has not yet committed to the drilling of angle bore holes considered potentially valuable by the NRC staff for the recognition of certain subsurface features.

- Regarding historically-poor core recovery in the unsaturated zone, DOE indicates that recent advances in drilling procedures and techniques as

applied at Apache Leap (Arizona) have resulted in excellent core recovery (95 percent) in unsaturated tuffs. The staff assumes this to mean, given the application of similar technology at the Yucca Mountain site, that core recovery would be much improved over that previously experienced at the site.

- DOE's response does not address the planned use of existing, qualified borehole-derived information in the development of its site characterization drilling program.

- Closure of this comment must await DOE confirmation of the integrated program and the NRC staff evaluations of Study Plan 8.3.1.9.2.1, Activity 8.3.1.2.2.4.10 (see Comment 4 response, p. 331), the Calico Hills Risk/Benefit Analysis, the C-Hole Complex study and unspecified attendant study plans.

- The NRC staff considers this comment open.

REFERENCE

Oliver, H.W., E.L. Hardin, and P.H. Nelson, 1990, "White Paper," Status of data, major results and plans for geophysical activities, Yucca Mountain Project. Yucca Mountain Project. YMP/90-38, U.S. Department of Energy, Las Vegas, Nevada, 1990.

Section 8.3.1.4.2 Investigation: Geologic Framework of the Yucca Mountain Site

Section 8.3.1.4.3 Investigation: Development of three-dimensional models of rock characteristics at the repository site.

Section 8.4.2.1 Rationale for planned testing

SCA COMMENT 35

The program of drifting in the north, combined with systematic drilling and feature sampling drilling, appears unlikely to provide the lithologic and structural information necessary to adequately investigate potentially adverse conditions at the site or insure that observations made and data collected will be representative of conditions and processes throughout the repository block. Also, it has not been demonstrated that the proposed site characterization plan provides for a sufficient amount of underground drifting to collect data necessary for designing the repository and analyzing repository performance.

EVALUATION OF DOE RESPONSE

- The response to this comment indicates that the concerns expressed are being addressed by three ongoing project tasks:
  (1) The Exploratory Shaft Facility Alternative Analysis,
  (2) The Prioritization of Surface-Based Testing Activities, and
  (3) Calico Hills Risk/Benefit Analysis.

- Resolution of this comment must await the completion and NRC staff evaluation of the referenced documents.

- The NRC staff considers this comment open.

Section 8.3.1.4.2 Investigation: Geologic framework of the Yucca Mountain site

SCA COMMENT 36

The technical rationale for this investigation states that the perimeter drift defines an area of a significantly lower concentration of faults than has been mapped in surrounding areas. However, based on other parts of the SCP, this concept may not be accurate. Further, there is no apparent indication that studies in SCP address the potential impact on system performance of the presence within the perimeter drift (i.e., in emplacement areas) of a significant number of faults, some of which may be favorably oriented for failure under the present stress regime.

EVALUATION OF DOE RESPONSE

- The response to this comment suggests that the staff misunderstands the role of the exploratory drifts in relation to imbricate faulting and the perimeter drifts. The staff considers that it does not misunderstand the above mentioned relation and that the response to this comment does not satisfactorily address the issue of whether the portrayal of the imbricate fault zone within the boundaries of the perimeter drift is in error or whether DOE intends to include portions of the imbricate fault zone within the repository boundaries. The response to comment 36 indicates only that "DOE position has been to avoid significant concentrations of faults."

- Closure of this comment must await clarification that permits the staff to judge how many faults represent a "significant concentration." The Exploratory Shaft Facility Alternative Study will need to be evaluated with respect to plans to identify imbricate faults within the repository perimeter. In addition, if portions of the imbricate fault zone are incorporated into the repository, then an assessment of the impact these faults may have on the ability to meet 10 CFR 60.133(h) needs to be performed by DOE and evaluated by the NRC staff.

- The NRC staff considers this comment open.

Section 8.3.1.4.2.2 Study: Characterization of the structural features within the site area, p. 8.3.1.4-65

SCA 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

- o 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.
- o DOE's response also includes an extensive list of features that will be used to distinguish blasting-induced fractures from pre-existing natural fractures.
- o The NRC staff considers this comment closed.

Section 8.3.1.4.2.2.4 Activity: Geologic Mapping of the Exploratory Shaft and Drifts

SCA COMMENT 38

One of the objectives of Activity 8.3.1.4.2.2.4 is to characterize major faults and fault zones in the subsurface. There is no justification given for not characterizing minor faults and fault zones, although these features potentially present the same kinds of hazards as do major faults, even though on a smaller scale.

EVALUATION OF DOE RESPONSE

- DOE has provided additional information about the distinction between "predetermined" mapping criteria and mapping criteria that cannot be predetermined and has correctly pointed out that the SCP's scope is not to provide the level of detail reserved for Study Plans and technical procedures (see DOE's response to Question 6.)

- DOE indicates that sufficient flexibility will be built into the geologic mapping program to permit the responsible geologist to make independent observations about mapping criteria beyond those outlined in technical procedures. (See DOE's response to Question 6.)

- DOE indicates that fractures with sufficient continuity to qualify as a minor fault will be captured by the fracture mapping methods, as indicated in Study Plan 8.3.1.4.2.2, even if the requisite offset cannot be fully established.

- As DOE indicates, in Study 8.3.1.8.2.1, once underground drifts have been constructed and mapped through the faults with potential performance significance, the data acquired through this mapping would be used to establish criteria for recognizing subsurface faults so that similar structures in the repository can be avoided.

- DOE indicates that the criteria for mapping expected geologic features will be explicitly outlined in appropriate technical procedures.

- The NRC staff considers this comment closed.

Section 8.3.1.4.3.1.1 Activity: systematic drilling program

SCA COMMENT 39

No assessment is provided to support the estimated maximum range of statistical correlation for porosity and air permeability (3000 feet). This estimate is one of the bases for determining the location of the boreholes of the systematic drilling program. Further, no technical analyses or specific plans to obtain technical analyses, are provided to justify the assumption that the spatial variability of porosity, saturated hydraulic conductivity and saturation can serve as surrogates in determining the spatial variability of other parameters needed by performance assessment and design issues.

EVALUATION OF DOE RESPONSE

- It was not the objective of this comment to prevent the use of surrogates, but to make sure that when surrogates are used, reasonable techniques and studies are performed to demonstrate their validity. Two examples were cited in the "BASIS" of the comment where surrogates had been chosen that lacked supporting studies of their validity. In the first example, porosity and air permeability measurements from outcrops of the Calico Hills unit were used as surrogates to establish the minimum spacing between boreholes in the systematic drilling program. The SCP cited a publication by Rautman, et al, 1988, to support the choice of these parameters as surrogates . However, this publication was not available for staff review when the SCP was issued and therefore the choice of these parameters as surrogates was unsupported.

- The second example was a citation from page 8.3.1.4-101 of the SCP, which indicated that much of the analysis of spatial variability will depend upon detailed knowledge of a few selected rock characteristics including porosity, saturated hydraulic conductivity, and saturation. These parameters were to serve as surrogates in determining the spatial variability of several other parameters. However, the SCP did not describe analyses supporting the choice of porosity, saturated hydraulic conductivity, and saturation as surrogates. Furthermore the SCP did not describe any plans to conduct tests to demonstrate the validity of these parameters or any other parameters as surrogates.

- In evaluating the DOE response it was noted that DOE has discarded the concept of developing spatial structure estimates solely from a limited suite of properties (surrogate concept) as described in the Site Characterization Plan. Instead each parameter will be studied using statistical and geostatistical techniques to determine if the parameter is being adequately characterized. Further interaction of principal investigators with the Sample Overview Committee and in other forums will ensure that a statistical evaluation is consistent with its planned use in performance assessment and design.

- The DOE response also indicates that while the use of surrogates may not be required for systematic drilling program general planning and evaluation, the use of surrogates may be required in some instances. This may be required when an adequate amount of data cannot be obtained for some rock properties. This situation might occur as part of a particular engineering design or performance assessment analysis. Furthermore, if surrogates are required analytical techniques such as statistical cross

correlation and regression analysis will be used to establish their validity.

- The NRC staff considers this comment closed. The NRC staff considers that the commitment in the DOE response to conduct analyses to establish the validity of surrogates closes this comment. In summary, DOE recognizes that there is uncertainty with respect to the proper location of the systematic boreholes and that some of the boreholes may not be optimally located. However, the DOE states that the planned drilling pattern is warranted, because additional data is needed to improve the current estimates of data correlations. If some planned data collection activities are not adequate, it will be possible to determine the fact after testing and take corrective action.

REFERENCE

Rautman, et al, 1988, Estimates of Spatial Variability of Volcanic Tuffs, Yucca Mountain, SANDXX-XXX, in prep.

Section 8.3.14.3.1.1 Activity: Systematic Drilling Program, p. 8.3.1.4-93

SCA 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 text is unclear on this topic.

EVALUATION OF DOE RESPONSE

- DOE agreed with this comment and has stated in its response that Study Plan 8.3.1.4.3.1 (Systematic Acquisition of Site-Specific Subsurface Information) 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.

- The NRC staff considers this comment closed.

Section 8.3.1.4.3.1.1 Activity: Systematic drilling program, pp. 8.3.1.4/87-100

SCA 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.
- The NRC staff considers this comment closed.

Section 8.3.1.6 Overview of the Erosion Program

SCA COMMENT 42

The overall erosion program does not include an evaluation of escarpment retreat.

EVALUATION OF DOE RESPONSE

- o DOE indicates that the erosion program which includes an assessment of escarpment (western face of Yucca Mountain) retreat is to be addressed in the not-yet-developed Activity 8.3.1.6.1.1.3, An analysis of hillslope erosion at Yucca Mountain.
- o DOE apparently does not use the term "escarpment retreat" in the above activity and seems to indicate that the terms "hillslope erosion" and "escarpment retreat" are synonymous.
- o DOE, as a basis for not creating a separate study for the measurement of escarpment retreat, cites a 1988 study by Whitney and Harrington demonstrating, in DOE's opinion, that Yucca Mountain hillslope erosion rates (at least at the western face of the mountain) are very low, thus not warranting further study.
- o Notwithstanding the absence of such completed/approved technical procedures, DOE has apparently concluded that the bedrock erosion rate, as it applies to measuring escarpment retreat on the western flank of Yucca Mountain, is sufficiently low, based solely on the above report, to close out this particular segment of the hillslope erosion activity.
- o DOE indicates (SCP, p. 8.3.1.6-14) that three technical procedures (which serve as bases for activity validation) have yet to be developed.
- o Closure of this comment must await staff evaluation of Activity 8.3.1.6.1.1.3 and attendant technical procedures.
- o The NRC staff considers this comment open.

Section 8.3.1.6	Overview of the erosion program: Description of the future erosional rates required by the performance and design issues
Section 8.3.1.8	Overview of the postclosure tectonics program: Description of future tectonic processes and events required by the performance and design issues
Section 8.3.1.17	Overview of preclosure tectonics: Description of tectonics and igneous events required by performance and design requirements

SCA COMMENT 43

The rationale for numerical goals specified in Tables 8.3.1.17-3a, 8.3.1.17-4a and b, and 8.3.1.17-7 is poorly supported and the use of averaged values or rates for establishing acceptable limits for fault movement, rates of volcanism and rates of erosion does not provide for conservative assessments of potential hazards.

EVALUATION OF DOE RESPONSE

- DOE's intent was to use "goals" as stated in the SCP as a logical early step in the performance allocation in order to help scope the technical aspects of the site characterization program.
- DOE indicates that the SCP-stated performance allocation "goals", which are not to be confused with performance goals, represent arbitrary, or tentative, cut-off points for data collection, and further indicate approximate scale or level-of-detail. The performance allocation "goals" are based on experts' best judgments of limited, available data combined with the DOE's understanding of applicable regulations and are amenable to change as site characterization proceeds.
- As site characterization proceeds DOE intends to clarify the manner in which data gathered are used to build a SAR in support of license application.
- SCP-described site geotechnical investigation activities are designed to provide information and data needed for issue resolution and for the SAR and have been developed using preliminary performance allocation based on preliminary performance assessment of the total system and major subsystems. Continuing assessments will contribute to iterations of performance allocation as data are acquired.
- As the data from site investigation and testing become available they are to be evaluated through performance assessment for their contribution to site suitability, design, issue resolution, and performance issue resolution.
- DOE, in summary, acknowledges that current performance allocation "goals" and parameters and their logical relations can be improved and that performance allocation, as evinced in the SCP, provides a reasonable basis for identifying the initial focus and scope of the program.

- DOE further acknowledges that, as the process matures, modifications to both the allocation logic and site program should be anticipated.
- The Test and Evaluation Plan, which is currently under development by DOE, is to direct all site investigations, design and testing activities and the evaluation of such information.
- Closure of this comment is dependent upon the staff evaluation of the DOE's Test and Evaluation Plan, and also upon DOE's responses to the NRC staff's evaluations of Comments 1, 45, and 66.
- The NRC staff considers this comment open.

Section 8.3.1.8 Overview of the postclosure tectonics programs; Description of future tectonic processes and events required by the performance and design issues.

SCA COMMENT 44

The overall goal for waste package performance stated in this section of the SCP is not consistent with the interpretation of substantially complete containment discussed in Section 8.3.5.9 (Other comments related to "substantially complete containment" are Comments 5 and 80.)

EVALUATION OF DOE RESPONSE

- DOE has acknowledged that the goal indicated on page 8.3.1.8-27 is in error.
- DOE expects that revisions to the goals for waste package performance will be made as site characterization and engineered barrier system performance assessments progress.
- The NRC staff considers this comment closed.

Section 8.3.1.8 Overview of the postclosure tectonics program: Description of future tectonic processes and events required by the performance and design issues

SCA COMMENT 45

Reliance on volcanic rate calculations that are developed largely independent of consideration of the underlying volcano-tectonic processes appears likely to underestimate potential impacts on the performance of the repository.

EVALUATION OF DOE RESPONSE

- The response to this comment indicates that the only possible alternative in volcanic rate calculations is to rely on "a fundamental assumption of geology that the past geologic record provides the primary basis for predicting or bounding future geologic events." The staff supports such a deterministic approach. Further, the staff considers that supplemental activities exist (e.g., natural analog studies; deep seismic surveys) that, combined with the geologic record, provide mechanisms for approaching an understanding of Quaternary geologic processes at the site. In addition, the accuracy of assumptions stemming from an examination of the geologic record alone is largely dependent on the record being "robust" enough to provide an adequate data base for predicting or bounding future geologic events. The staff considers that evidence suggesting that the geologic record of Quaternary volcanism is "robust" to the point of accurately predicting the future likelihood of volcanic events has not been documented.

- DOE states that "At this stage of development of site characterization work, it is premature to expect probability calculations to reflect regional tectonic models." The staff considers that alternative tectonic models do exist for the Yucca Mountain region at the present time and that these alternatives should be incorporated into characterization activities and preliminary calculations about the likelihood of future volcanic events. An example of an alternative tectonic model for basaltic volcanism in the Yucca Mountain region is that proposed by Smith and others (1990) for structural control of basaltic volcanism at Yucca Mountain.

- DOE states that calculations of magma effusion rates suggest that a stochastic approach to probability calculations for the Yucca Mountain site is a conservative approach. The staff does not consider the calculations of magma effusion rates as presently defined to be robust enough to accurately or precisely predict whether magma production will increase or decrease in the next 10,000 yrs, particularly in the absence of the consideration of alternative models of magma rate production. Therefore, the staff does not consider the stochastic approach to probability calculations for volcanism at Yucca Mountain to necessarily be conservative.

- DOE suggests that this comment can be resolved after additional site characterization leads to development of regional tectonic models (Investigation 8.3.11.7.4; Study Plans 8.3.1.8.5.1 and 8.3.1.8.1.1) and calculations of magma effusion rates (Study Plan 8.3.1.8.1.1). Resolution of this comment must await NRC staff evaluations of the referenced study

plans and results of investigations which should consider volcano-tectonic processes, regional tectonic models, and volcanic rate calculations.

- The NRC staff considers this comment open.

REFERENCE

Smith, E.I., Feuerbach, D.L., Naumann, T.R., and Faulds, J.E., 1990, The area of most recent volcanism near Yucca Mountain, Nevada: Implications for volcanic risk assessment, in Proceedings High Level Waste Management, 1990, American Nuclear Society, p. 81-90.

Section 8.3.1.8 Overview of the postclosure tectonics program: Description of future tectonic processes and events required by the performance design issues (p. 8.3.1.8-40)

SCA COMMENT 46

The current representation of the physical domain for postclosure tectonics issues (i.e., brittle crust, southern Great Basin) appears to be inadequate to evaluate the full range of processes and events likely to occur at the site and should not act as a limit on conceptual tectonic models or site investigations.

EVALUATION OF DOE RESPONSE

- The response to this comment indicates that there is philosophical agreement between NRC and DOE that the definition of the "physical domain" should not be a limiting factor in consideration of alternative conceptual models and that areas for consideration of alternative conceptual tectonic models should be extended to areas outside of the southern Great Basin.

- The response indicates that the terms "physical domain" and geologic setting" are not synonymous.

- The response to SCA Comment 75 indicates the "geologic setting" will be defined specifically for different investigative elements of the SCP and that the specific meaning of the term should be readily apparent within the context of the individual investigation.

- The NRC staff considers this comment closed.

Section 8.3.1.8 Overview of the postclosure tectonics program: Description of future tectonic processes and events required by the performance design issues

SCA COMMENT 47

The approach to incorporating data derived in the postclosure tectonics program into an assessment of whether performance issues related to the waste package and engineered barrier system (EBS) requirements (10 CFR 60.113(a)) will be met is confusing and may result in an inaccurate assessment of performance.

EVALUATION OF DOE RESPONSE

- The response to this comment indicates that the concerns expressed will be addresssed in study plan 8.3.1.8.2.1 (Analysis of waste package rupture due to tectonic processes and events) and activity 8.3.5.9.4.1.1 (Deterministic rates of container degradation in the repository environment for anticipated and unanticipated processes and events).

- Closure of this comment must await DOE's submittal and NRC staff evaluation of the referenced documents.

- The NRC staff considers this comment open.

Section 8.3.1.8	Overview of the postclosure tectonics program: Description of future tectonic processes and events required by the performance design issues (p. 8.3.1.8-27)
Section 8.3.1.8.2.1.4	Activity: Assessment of waste package rupture due to faulting
Section 8.3.1.17	Overview of preclosure tectonics: Description of tectonic and igneous events required by performance and design requirements
	Table 8.3.1.17-3a Design and performance parameters related to surface facilities and preclosure fault displacement
Section 8.3.1.17.2	Studies to provide required information on fault displacement that could affect repository design or performance.

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.

EVALUATION OF DOE RESPONSE

- The response to this comment indicates that the concerns expressed will be addresssed using total probability of a given fault displacement occurring and that all available information on fault behavior will be used in determining this probability. In technical exchanges between the NRC staff and DOE, the NRC staff has indicated that deterministic assessments should be used to assess the hazard posed to the repository by fault displacement and that these deterministic assessments can be supplemented by probabilistic assessments. The NRC staff continues to consider deterministic assessments to be the primary tool for evaluating fault displacement related hazard.

- The response also indicates that slip rates represent the "most reliable descriptor of fault activity" at the site. However, the staff considers that limitations due to the magnitude of offset (greater than 1 m) necessary for detection and the inability to assess the magnitude of strike-slip component suggest that this descriptor could lead to estimates that significantly underestimate fault activity. The NRC staff considers that an acceptable approach to the assessment of fault displacement hazard would include the use of slip rate data supplemented by other deterministic assessments (e.g., maximum event offset).

- Closure of this comment must await a demonstration by DOE that (1) use of slip rates for determining hazard does not provide overly optimistic predictions of the effects of faulting on repository performance, or

(2) 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 posed by faulting are being considered.

- The NRC staff considers this comment open.

Section 8.3.1.8	Overview of the postclosure tectonics program: Description of future tectonic processes and events required by the performance and design issues.
Investigation 8.3.1.8.1	Studies to provide information required on direct releases resulting from volcanic activity.
Section 8.3.5.13	Issue Resolution Strategy for issue 1.1: Will the mined geologic disposal system meet the performance objective for limiting radioactive releases to the accessible environment as required by issue 10 CFR 60.112 and 40 CFR 191.13?, Disturbed case (A-1): direct release in basaltic volcanism.
Table 8.3.5.13-10.	Performance parameters for scenario class A-1 (extrusive magmatic events)

SCA COMMENT 49

If the results of the investigations on direct release resulting from volcanic activity do not provide information which shows that either the probability and/or consequence resulting from such a scenario is lower than the tentative parameter goals stated in Table 8.3.1.8-1b and Table 8.3.5.13-10, the Yucca Mountain site will fail to meet the requirements for overall system performance.

EVALUATION OF DOE RESPONSE

- The response to Comment 49 acknowledges that the goal for volcanism presented in the SCP would exceed the criteria of 40 CFR 191.

- The response to Comment 49, acknowledges that the goal for volcanism may be a candidate for revision.

- The response to Comment 49 also contends that the goal set in the SCP serves its purpose of requiring investigations which will determine the appropriate probabilities for inclusion in licensing performance assessment.

- The response to Comment 49 references the response to Comment 2 which in turn references the response to Comment 1. In the response to Comment 1, DOE states:

  > "The document which directs all site geotechnical investigation and repository design/testing activities and their evaluations is the Test Evaluation plan..."

  It appears that the Test Evaluation Plan is an important document for determining how DOE is directing its program.

- The response to Comment 1 states:

  > "Thus, performance allocation [as presented in the SCP] cannot, on the basis of these initial judgements, be expected to "provide assurance that the site characterization program will develop the required information."

- To develop a complementary cumulative distribution function (CCDF) to determine compliance with the overall system performance objective it will be necessary to plot probability of scenarios against the consequence of these scenarios. Volcanism is but one of the scenarios that will need to be folded into the overall CCDF. In the response to Comment 49, the DOE states:

  > "... if there were only a .01 probability that .001 of the waste were released, the analysis in the SCP would be inapplicable because the releasing event would have a probability of less than 10e-8..."

  This example appears to be an inappropriate way to to determine if a scenario should be included in a CCDF.

- In Appendix B of 40 CFR 191, EPA has stated that it assumes that performance assessments need not consider categories of events or processes that are estimated to have less than one chance in 10,000 of occurring over 10,000 years. This general language was also used in the proposed rulemaking to conform 10 CFR 60 to the EPA standard. It is the staff's present understanding that, while there may be a slight restructuring in the final EPA standard, this general guidance will still apply. It is therefore important that DOE recognize the wording and intent of this guidance as stated in the proposed NRC rulemaking (See 51 FR 22292):

  > "The term 'categories' is used to refer to general classes of processes and events, such as faulting, volcanism, or drilling. Subsets of these general categories, such as drilling which intersects a canister or fault displacement of a specific magnitude, may need to be retained in an analysis if the general category has been finely divided into a large number of specific process or event descriptions, each with reduced probability of occurrence."

  In determining compliance with the overall system performance objective, DOE needs to assure that they are assessing the total effects from volcanism, not the just the effects from artificially subdivided specific process or event descriptions.

- Comment 49 was directed at assuring that sufficient information would be obtained during site characterization such that compliance with the overall system performance objective could be determined. The staff made numerous comments on the methodology being proposed by DOE to demonstrate compliance with the overall system performance objective, and the majority of these concerns have not been resolved. See, for example, comments 95, 98, 99, 105, 107, and 108. Until these concerns can be resolved, comment 49 cannot be closed.

- Some of the NRC staff's concerns may be addressed in documents which have not yet been received for review. For example:

  The NRC staff has not reviewed the DOE Test and Evaluation Plan to determine how the volcanism issue is being handled in the context of the overall program, or how the Test and Evaluation Plan links with the information which had been presented in the SCP.

  The NRC staff has only seen two of the 20+ study plans which are aimed at obtaining information which will be needed to resolve the

overall concern related to volcanism. Until these study plans are reviewed the staff is unsure as to the entire planned volcanism program.

- Comment 49 is directly linked with the overall concerns presented in Comment 1, and the staff does not consider that Comment 1 has been closed. Until Comment 1 is closed, Comment 49 cannot be closed.

- Closure of Comment 49 must also await closure of the other above referenced comments and review of the referenced DOE study plans and documents such as the Test and Evaluation Plan.

- The NRC staff considers this comment open.

Section 8.3.1.8	Overview of the postclosure tectonics program: Description of future tectonic processes and events required by theperformance and design issues
Table 8.3.1.8-2b	Investigation 8.3.1.8.2 - Studies to provide information required on rupture of waste packages due to tectonic events
Section 8.3.1.17	Overview of preclosure tectonics: Description of tectonic and igneous events required by performance and design requirements
Table 8.3.1.17-3b	Characterization parameters related to surface facilities and preclosure fault displacement

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.

EVALUATION OF DOE RESPONSE

- The response to this comment indicates that the concerns expressed are being addressed by seven project tasks: (1) Study Plan 8.3.1.17.4.2, Location and recency of faulting near prospective surface faulting [sic], (2) Study Plan 8.3.1.17.4.3, Quaternary faulting within 100 km of Yucca Mountain, (3) Study Plan 8.3.1.17.4.4, Quaternary faulting proximal to the site within northeast-trenching [sic] fault zones, (4) Study Plan 8.3.1.17.4.56 [sic], detachment faults at or proximal to Yucca Mountain, (5) Study Plan 8.3.1.17.4.6, Quaternary faulting within the site area, (6) Study Plan 8.3.1.17.4.7, Subsurface geometry and concealed extensions of Quaternary faults at Yucca Mountain, and (7) Study Plan 8.3.1.17.4.12, Tectonic models and synthesis.

- The response agrees that the approach to fault characterization will consider alternative models of faulting.

- The NRC staff considers this comment closed.

Section 8.3.1.8 Overview of the preclosure tectonics program: Description of future tectonic processes and events required by the performance and design issues

Section 8.3.1.17 Overview of the preclosure tectonics: Description of tectonic and igneous events required by performance and design requirements

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.

EVALUATION OF DOE RESPONSE

- In its response, DOE states "If the prototype work provides positive results, then this information would be part of Study Plans that will outline the required geophysical surveys designed to accomplish specific objectives in characterizing crustal structures."

- In the "White Paper" DOE states: "Implementation and possible elaboration of part of this program,..., depends on the results from planned peer review, feasibility testing, and initial data collection and analysis."

- DOE does not state the alternative programs to be used for the identification and characterization of both the deep crustal and shallow geologic features and their interrelationship if the prototype work, feasibility, testing, or peer review do not provide positive results.

- Closure of this comment must await NRC staff evaluations of Activity 8.3.1.4.1.2 (sic) and the report of the Seismic Peer Review Panel, and unspecified study plans mentioned in the response on p. 147.

- The NRC staff considers this comment open.

REFERENCE

DOE, 1990, "White Paper," Status of Data, Major Results, and Plans for Geophysical Activities, Yucca Mountain Project. Yucca Mountain Project, YMP/90-38, U.S. Department of Energy, Las Vegas, Nevada, 1990

Section 8.3.1.8.1 Investigation-Volcanic Activity
Section 8.3.1.8.5.1 Study-Volcanic Features
Section 8.3.1.8.5.2 Study-Intrusive Features
Section 8.3.1.17.1 Studies-Volcanic Activity

SCA COMMENT 52

No specific geophysical program appears to be planned to identify volcanic/igneous features and their extent under or close to the site.

EVALUATION OF DOE RESPONSE

- DOE in its response states "...that a geophysical subprogram for volcanism studies has been developed for investigating the possible presence of magma bodies beneath the Yucca Mountain region (Activity 8.3.1.8.1.1.3). The study plan... (8.3.1.8.1.1, Probability of magmatic disruption...) contains an explanation of a geophysical program to address this issue."

- In the study plan (Activity 8.3.1.8.1.1, p. 16), DOE states: "If magma is present in the crust beneath Yucca Mountain, it should be confirmed through application and evaluation of the results of multiple geophysical methods." DOE continues to state "No direct geophysical measurements are initially planned for this activity."

- Study Plan 8.3.1.8.1.1 deals mainly with analyzing existing data as stated on p. 15: "The technical rationale for this activity is to review geophysical data collected in the vicinity of the Yucca Mountain site to determine if there are any indications of the subsurface magma."

- DOE did not provide or propose any new specific geophysical program for identifying volcanic/igneous features.

- Closure of this comment must await NRC staff evaluations of: (1) unspecified plan or plans to integrate the geophysical program and studies of volcanic/igneous features, and (2) the results of the multiple geophysical methods proposed by DOE on p. 16 of Study Plan 8.3.1.8.1.1 for identifying magma.

- The NRC staff considers this comment open.

REFERENCE

DOE, 1990. Study Plan 8.3.1.8.1.1 Probability of Magmatic Disruption of the Repository, Rev. 0, approved 9/90. Yucca Mountain Project Office, Las Vegas, NV.

Section 8.3.1.9.2 Study: Natural resource assessment of Yucca Mountain, Nye County, Nevada

SCA COMMENT 53

The program of investigations for natural resources assessment as presented in the SCP appears to be unsatisfactory for consideration of potential natural resources and natural resource models at the site.

EVALUATION OF DOE RESPONSE

- DOE indicates that (1) the multiple concerns identified in this comment will be addressed in Study Plan 8.3.1.9.2.1 (Natural Resource Assessment of Yucca Mountain, Nye County, Nevada) and that (2) the study plan is in preparation.

- Based upon DOE's logic diagram for Study Plan 8.3.1.9.2.1 (SCP Figure 8.3.1.9-3, p. 8.3.1.9-22) it is clear that the response to this comment will be dependent upon DOE's completion of not only the above study plan, but numerous supportive studies and investigations.

- Based upon the descriptions of the studies and activities shown on the above logic diagram (SCP Figure 8.3.1.9-3) it is not clear that the concerns raised in this NRC question will be addressed fully.

- Notwithstanding the studies and investigations identified in the logic diagram, DOE indicates (Activity 8.3.1.8.5.2.3, SCP p. 8.3.1.9-35) that even more activities are required to support the Natural Resources Assessment of Yucca Mountain study plan than those indicated on the logic diagram.

- Closure of this comment must await staff evaluations of Study Plan 8.3.1.9.2.1 and other relevant study plans and investigations such as those identified by the staff through its evaluation of Comment 34.

- The NRC staff considers this comment open.

Section 8.3.1.15	Overview of thermal and mechanical rock properties program
Section 8.3.1.4	Overview of the rock characteristics program
Section 8.3.2.2.	Configuration of underground facilities (postclosure)
Section 8.4.2.3.1	Exploratory shaft facility testing operations, layout constraints, and zones of influence

SCA 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 in technical reports that evolve from the site characterization program variances in how the program for data acquisition and analysis, and for performance modeling evolves from those discussions that DOE considered adequate for the SCP.

- Based on DOE's commitment to explain those variances as the program evolves, the NRC staff considers this comment closed.

Section 8.3.1.15.1 Investigation: Studies to provide the required information for spatial distribution of thermal and mechanical properties, pages 8.3.1.15-23/31

SCA 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 would be checked as new information (i.e., site-characterization data and results of additional 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 staff is concerned that if DOE waits until the data is collected to evaluate the approach to determine the number of tests required to determine various rock properties, several consequences may follow:

  (1) The ability to find "surprises" in the data may be lost; and
  (2) Data which "makes sense" may be accepted, and data which does not "make sense" may be rejected arbitrarily.

- Progress toward closure of this comment will require DOE to submit for NRC staff review results of on-going and future sensitivity studies as the bases for assigning needed confidence levels. DOE also needs to present its evaluation of such studies in assessing the validity of the statistical basis for the determination of sample size.

- The NRC staff considers this comment open for two reasons: (1) DOE has deferred any changes in the technical bases for site characterization until new information is available, and (2) DOE's response did not clarify any of the specific points raised in Comment 55.

Section 8.3.1.15.1 Investigation: Studies to provide the required information for spatial distribution of thermal and mechanical properties, p. 8.3.1.15-31

Section 8.3.5.20 Analytical techniques requiring significant development

SCA 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 discussion of model validation 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." However, 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. DOE states in its response to this comment that 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 further indicates that it "is currently developing a general validation strategy,... which will be implemented through the 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 concerns that form the basis of Comment 56.

- Progress toward closure of Comment 56 will require DOE to submit (1) the study plans relating to the in situ tests cited in the DOE's response, when they become available, and (2) the general validation strategy, to be implemented by DOE in the Test and Evaluation Plan.

- The NRC staff considers this comment open.

Section 8.3.1.15.1.5	Study: Excavation investigations, pp. 8.3.1.15-45/52
Section 8.3.1.15.1.8	Study: In situ design verification, pp. 8.3.1.15-70/76
Section 8.3.2.2.5	Information need 1.11.5, p. 8.3.2.2.5
Section 8.4.2.3.4.4	Exploratory shaft facility underground construction and operations-blasting, pp. 8.4.2-180/195

SCA 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. 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.

- Progress toward closure of this comment will require DOE to submit the referred Study Plan 8.3.1.15.1.8 and include in the subject study plan activities related to investigating the advisability and feasibility of using mechanical excavation methods as recommended by NRC.

- 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.

- The NRC staff considers this comment open.

Section 8.3.1.15.1.8 Study: In-Situ Design Verification, p. 8.3.1.15-70

SCA 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 (8.3.1.15.1.8) is to collect and document information made available through construction of the Exploratory Shaft Facility (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."

- DOE's response further states that "A more detailed discussion of the purpose and rationale for this study will be provided in Study Plan (8.3.1.15.1.8), which is in review."

- The NRC staff considers this comment closed.

Section 8.3.1.17 Overview of preclosure tectonics: Description of tectonic and igneous events required by performance and design requirements

SCA COMMENT 59

The information presented for the program of investigations for faulting does not allow the NRC staff to determine what investigations will actually be conducted. In addition, the sequencing of many geophysical and geologic activities related to faulting may lead to data collection activities that are inadequate to support assessments of performance and design bases.

EVALUATION OF DOE RESPONSE

- The response to this comment indicates that the concerns expressed are being addressed by the Testing Prioritization Task (TPT).
- Closure of this comment must await the completion and NRC staff review of the TPT.
- The NRC staff considers this comment open.

Section 8.3.1.17 Overview of preclosure tectonics: Description of tectonic and igneous events required by performance and design requirements.

Table 8.3.1.17-3a Design and performance parameters related to surface facilities and preclosure fault displacement

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.

EVALUATION OF DOE RESPONSE

- The response to Comment 60 referred NRC to the response to Comment 43. The response to Comment 43 also references response to Comment 1.

- The NRC staff's recommendation presented in Comment 60 suggests that DOE provide justification which should include a discussion of the interrelationship of the characterization parameters, performance and design parameters, and goals with the design criteria and performance objectives of 10 CFR Part 60. Neither the response to Comment 43 nor the response to Comment 1 provides this information.

- The response to Comment 1 references the DOE Test and Evaluation Plan. In the response to Comment 1 DOE states the Test and Evaluation Plan will:
  "... govern how the site study/testing program in the SCP is carried out, how recommended changes are evaluated, and how and when DOE knows when enough data has been gathered to fulfill the needs of the characterization program."
  As the purpose of site characterization is to assure that enough data has been gathered such that the licensing concerns can be resolved, it appears that a response to Comment 60 many be found, indirectly, in the Test and Evaluation Plan. The NRC staff had not received the Test and Evaluation Plan for review as of the time DOE's SCA comment responses were issued.

- Closure of Comment 60 must await closure of Comment 1 and NRC review of the Test and Evaluation Plan.

- The NRC staff considers this comment open.

Section 8.3.1.17	Overview of preclosure tectonics: Description of tectonic and igneous events required by performance and design requirements
Table 8.3.1.17-3a	Design and performance parameters related to surface facilities and preclosure fault displacement

SCA COMMENT 61

The program of investigations for faulting appears to assume that any future faulting will follow old faulting patterns. The NRC staff considers that this is not a reasonably conservative assumption, and does not consider that this assumption is technically justified.

EVALUATION OF DOE RESPONSE

- The primary purpose of this comment was to assure that DOE consider both faulting that may occur along pre-existing fault planes, and along new and unrecognized fault planes, in the design and analysis.
- The DOE response to Comment 61 considers that NRC staff misstated the DOE position.
- In the basis for Comment 61, the NRC staff stated that this comment was a continuation of concerns expressed in CDSCP Comment 50.
- The DOE response presents no new information, but simply restates information which had been presented in response to CDSCP Comment 50.
- DOE states that the "probability of new faulting" will be considered in Study Plan 8.3.1.17.2.1.
- Closure of Comment 61 must await the staff's evaluation of those portions of Study Plan 8.3.1.17.2.1 dealing with new faulting.
- The NRC staff considers this comment open.

Section 8.3.1.17	Overview of preclosure tectonics: Description of tectonic and igneous events required by performance and design requirements
Table 8.3.1.17-3a	Design and performance parameters related to surface facilities and preclosure fault displacement

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 distance in designing the program of investigations and in performing the resultant design and analysis.

EVALUATION OF DOE RESPONSE

- The response to this comment appears to be built on the premise that probabilistic based design parameters will be acceptable to NRC for licensing. For example, NRC is referred to Study Plan 8.3.1.17.2.1 for explanation of DOE's plans to evaluate the probability of surface faulting under facilities important to safety.

- The NRC staff has questioned the rationale for the DOE design and performance parameter (See for example, Comment 60) and has not yet received a satisfactory response to its concerns.

- The response to this comment indicates that the concerns expressed will be addressed using total probability of a given fault displacement occurring and that all available information on fault behavior will be used in determining this probability. In technical exchanges between the NRC staff and DOE, the NRC staff has indicated that deterministic assessments should be used to assess the hazard posed to the repository by fault displacement and that these deterministic assessments should be supplemented by probabilistic assessments. The staff continues to consider deterministic assessment to be the primary tool for evaluating fault displacement related to hazard.

- Closure of Comment 62 must await NRC staff evaluation of Study Plan 8.3.1.17.2.1.

- The NRC staff considers this comment open.

Section 8.3.1.17	Overview of preclosure tectonics: Description of tectonic and igneous events required by performance a design requirements
Table 8.3.1.17-3a	Design and performance parameters related to surface facilities and preclosure fault displacement

SCA COMMENT 63

The information presented for the program of investigation 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.

EVALUATION OF DOE RESPONSE

- Comment 63 was directed, primarily, at requesting that DOE provide an integrated program of geologic investigations. The response to Comment 63 states that this will be done, but does not provide any means of allowing the NRC staff to evaluate how DOE is integrating the program at this time. Apparently the program for integrating such investigations is contained within the Test and Evaluation Plan and in study plans such as the 13 listed in Table 1-4 of study plan 8.3.1.17.4.2.

- Comment 63 also requested information on how ongoing and pre-existing information would be incorporated into the program. The comment response states: "..this study currently assumes that little or no existing data will be qualified," and "The U.S. Department of Energy has recently evaluated past geophysical surveys and resulting data and will determine whether additional geophysical surveys and boreholes will be needed to characterize Midway Valley."

  The staff considers that if little to no data will be qualified that it will be necessary to conduct additional borings and geophysical surveys. If, however, it is determined that additional borings and geophysics are not needed it would then appear that the data could only be obtained by qualifying pre-existing data. It does not appear that sufficient data for licensing could be obtained unless DOE pursues one of these two options.

- DOE needs to demonstrate that it has developed an integrated test and evaluation program to obtain sufficient data either through qualification of pre-existing data or through obtaining new data such that the underlying licensing concerns can be resolved. In several of the other DOE comment responses (See, for example, response to Comment 1) it appears that DOE is attempting to use the Test and Evaluation Plan to accomplish this task.

- Closure of Comment 63 must await staff evaluation of the Test and Evaluation Plan and relevant study plans.

- The NRC staff considers this comment open.

Section 8.3.1.17.2 Investigation: Studies to provide required information on fault displacement that could affect repository design or performance

Table 8.3.1.17-4a Design and performance parameters related to underground facilities and preclosure fault displacement

SCA COMMENT 64

The characterization parameters for the identification and characterization of "significant Quaternary faults" in the area of the repository block do not appear to fulfill the requirements in 10 CFR 60, such as investigating and evaluating the effects of potentially adverse natural conditions.

EVALUATION OF DOE RESPONSE

- The response to this comment cites the previous technical exchanges between the NRC staff and DOE, noting that resolution of this issue requires continued dialogue.
- The NRC staff most recently discussed its position on the identification and investigation of fault displacement and seismic hazard at a technical exchange with DOE in February 1991 (J. Linehan to D. Shelor, dated March 15, 1991).
- Progress toward closure of this comment may require further interactions between the NRC staff and DOE.
- The NRC staff considers this comment open.

REFERENCE

U.S. Nuclear Regulatory Commission, Letter from J.J. Linehan, NRC, to D.E. Shelor, DOE; Subject: Minutes from the February 20, 1991 Technical Exchange, March 15, 1991, 2 pp. plus 1 enclosure and 4 attachments.

Section 8.3.1.17.2.1.2 Activity: Assess the potential for displacement on faults that intersect underground facilities

SCA COMMENT 65

The use of domains to define areas of "faulting potential" does not appear to be a reasonably conservative and technically justifiable approach to assess the potential for faulting at the site area and could underestimate the fault displacement hazard to the repository.

EVALUATION OF DOE RESPONSE

- The response to this comment indicates that the concerns expressed are being addressed in Study Plan 8.3.1.17.2.1, Faulting potential at the repository, particularly in Activity 8.3.1.17.2.1.2.
- The response also states that "there is no assumption stated or implied in the SCP that such faulting will be restricted to a particular domain."
- The NRC staff considers this comment closed.

Section 8.3.1.17.3.1.2 Activity: Characterize 10,000-year cumulative slip earthquakes for relevant seismogenic sources (p. 8.3.1.17-72)

SCA COMMENT 66

Since the 10,000-year cumulative slip earthquake (10-kyr CSE) methodology assumes that the average cumulative slip over 10,000 years is released in a single event, it appears that recurrence is implied to be fixed at 10,000 years. It is questionable whether such a methodology can properly characterize the fault activity, and the related seismic activity, in the site region.

EVALUATION OF DOE RESPONSE

- The DOE response provided no new information to address this comment. Furthermore, the response acknowledges that "...more detailed study should be conducted to show that the facility is inherently rugged to ground motion..."
- The NRC staff considers that the CSE methodology may be a simplified approach to estimate ground motion design but it is not a conservative way to estimate the maximum earthquake the proposed facility could be exposed to.
- DOE did not show the relation between the 10,000-year CSE and the maximum earthquake the facility may be exposed to.
- The NRC staff will accept a deterministic approach supplemented by a probabilistic approach that would provide the necessary information to evaluate the seismic design of the facility.
- Closure of this comment must await the comparison between the CSE and the maximum earthquake, and a detailed study that shows the facility can conservatively withstand exceeding design basis ground motion.
- The NRC staff considers this comment open.

Section 8.3.1.17.3.4 Study: Effects of local site geology on surface and subsurface motions (p. 8.3.1.17-77)

SCA COMMENT 67

The data compiled according to Activity 8.3.1.17.4.1.2, i.e., having a magnitude cutoff of 5.5, may not be sufficient to support an evaluation of the effect of local site geology on surface and subsurface motions.

EVALUATION OF DOE RESPONSE

- In its response, DOE clearly states "The U.S. Department of Energy does [not]* intend to imply that such information would not be collected for smaller events. In fact, such information would be compiled where reasonable and practical."
- The DOE response indicated that the additional parameters listed in the SCP on p. 8.3.1.17-88 will also be compiled for small events.
- The NRC staff considers this comment closed.

*The word "not" was omitted from DOE's response; a subsequent telephone call to DOE provided verbal assurance that "not" should have been present at this point in the response.

Section 8.3.1.17.4.5 Study: Detachment faults at or proximal to Yucca Mountain

SCA COMMENT 68

Other aspects of detachment faulting in addition to those described in Section 8.3.1.17.4.5 regarding key questions to be answered on earthquake sources do not appear to be treated as similarly potentially significant.

EVALUATION OF DOE RESPONSE

- The DOE response to this comment indicates that the concerns expressed are being addressed by Study Plan 8.3.1.17.4.12, Tectonic Models and Synthesis.
- Because DOE did not respond directly to, or provide any new information regarding the concerns expressed in the comment and its bases, closure of Comment 68 must await DOE's completion of, and NRC staff evaluation of, the referenced document.
- The NRC staff considers this comment open.

Section 8.3.1.17.4.5.5 Activity: Evaluate the age of detachment faults using radiometric ages

SCA COMMENT 69

The SCP does not appear to integrate and synthesize data resulting from the planned activities characterizing northwest-trending faults.

EVALUATION OF DOE RESPONSE

- The response to this comment indicates that the concerns expressed are being addressed by three study plans under development: (1) the study plan on Tectonic Models and Synthesis (8.3.1.17.4.12), (2) the study plan on Quaternary faulting within the site area (8.3.1.17.4.6), and (3) the study plan on Quaternary faulting within 100 km of Yucca Mountain (8.3.1.17.4.3).

- Because DOE provided only minimal information on how the NRC concerns are being addressed by the three referenced study plans, closure of this comment must await DOE's completion of, and NRC staff evaluation of, those study plans.

- The NRC staff considers this comment open.

Section 8.3.2.2 Issue resolution strategy for Issue 1.11, Function 3: Limit potential for excavation-induced changes in rock mass permeability. Permeability modification associated with excavation process, p. 8.3.2.2-14

SCA 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

- In response to this comment, DOE acknowledges that control of blast damage is important in underground repository facilities. In addition, 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 Alternatives Study.

- The NRC staff considers this comment closed.

Section 8.3.2.5 Issue resolution strategy for Issue 4.4: Are the technologies of repository construction, operation, closure, and decommissioning adequately established for the resolution of the performance issues?

Table 8.3.2.5-2 Preliminary performance allocation for System Element 1.1.2, subsurface (pages 8.3.2.5-13 through 8.3.2.5-17)

SCA COMMENT 71

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 in the repository.

EVALUATION OF DOE RESPONSE

- The response to this comment, while providing some discussion of DOE's approach to the assessment of fault displacement hazard at Yucca Mountain, does not address NRC's concerns about the concept of "significant Quaternary fault" expressed in the bases for this comment.

- The response to this comment indicates that the concerns expressed are being addressed by three ongoing project tasks: (1) The Exploratory Shaft Facility Alternatives Study, (2) The Prioritization of Surface-Based Testing Activities, and (3) Calico Hills Risk/Benefit Analysis, as well as each of the studies in the Data Collection and Analysis Investigation (8.3.1.17.4), particularly Study Plan 8.3.1.17.4.12, Tectonic Models and Synthesis.

- Closure of this comment must await the completion and NRC staff evaluation of the referenced documents.

- The NRC staff considers this comment open.

Section 8.3.3.1 Overview of Seal Program, p. 8.3.3.1-1/9

SCA 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

- In this comment, the NRC staff has recommended that DOE should plan its sealing program on the basis that seals will be needed until and unless it can be demonstrated otherwise. In its response, DOE has recognized that "... DOE may need to reevaluate its seals program upon completion of the ESF Alternatives Study." In addition, DOE "...agrees in principle with the NRC that continued sealing investigations should progress until such time as a definitive conclusion can be reached...." However, DOE's response appears to defer a commitment to accept the NRC recommendation at least until after completion of the ESF Alternatives Study.

- DOE's response further states that in the ESF Alternatives Study 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."

- Progress toward closure of this comment will require DOE's submittal and NRC review of the relevant sections of the ESF Alternatives Study which address the NRC staff concern expressed in this comment.

- The NRC staff considers this comment open.

Section 8.3.3.2.1 Information Need 1.12.1, Technical basis for addressing the information need, parameter 8, p. 8.3.3.2-34

SCA 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 the 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 satisfactorily addresses this portion of the NRC's concern.

- DOE's response does not, however, satisfactorily address the other two portions of the NRC comment as described below:

  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 analyses with consideration of alternative inflow and outflow scenario (e.g., preferential flow channels), recommended in the NRC comment, will be performed.

- Since DOE has not provided the information needed (at the level of detail expected of investigations in the SCP, closure of this comment will depend on DOE's submittal and NRC staff review of future plans with regard to in situ testing of seals and future plans to perform alternative inflow and outflow scenario analyses that DOE may perform.

- The NRC staff considers this comment open.

REFERENCES

Fernandez, J.A., P.C. Kelsall, J.B. Case, and D. Meyer, 1987. Technical Basis for Performance Goals, Design Requirements, and Material Recommendations for the NNWSI Repository Sealing Program, SAND84-1895, Sandia National Laboratories, Albuquerque, N. Mex.

Fernandez, J.A., T.E. Hinkebein, and J.B. Case, 1988. Selected Analyses to Evaluate the Effect of the Exploratory Shafts on Repository Performance at Yucca Mountain, SAND85-0598, Sandia National Laboratories, Albuquerque, N. Mex.

Section 8.3.3.2.2.3 Study 1.12.2.3: In-situ testing of seal components, pp. 8.3.3.2-41/62

SCA 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

- While DOE's response indicates that testing of sealing components will be performed as part of the ESF testing, there is no explanation of how this will be done. A plan indicating the nature, schedule, and the depth of testing, and a study plan dealing with field testing are in preparation.
- 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 may be made toward closure 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 NRC staff considers this comment open.

Section 8.3.4.2.4.4 Study 1.10.4.1: Engineered barrier system field tests (p. 8.3.4.2-57).

Section 8.3.5.7 Issue resolution strategy for Issue 4.1: Can the higher-level findings required by 10 CFR Part 960 be made for the qualifying condition of the preclosure system guideline and the disqualifying and qualifying conditions of the technical guidelines for surface characteristics, rock characteristics, hydrology, and tectonics? (p. 8.3.5.7-11).

Section 1.8.1.1 Geomorphology (p. 1-325).

Section 1.8.1.4 Seismology and seismicity (p. 1-335).

Section 1.8.1.7 Mineral and hydrocarbon resources (p. 1-342).

SCA COMMENT 75

The term "geologic setting" is cited frequently throughout the SCP in reference to diverse subject areas comprising the "geologic setting;" however, the term itself has neither been defined (see SCP, Volume VIII, Part B: Glossary and Acronyms) nor used consistently, that is, the component natural systems have not been systematically identified and described in plans to characterize them.

EVALUATION OF DOE RESPONSE

- DOE indicates that the term "geologic setting" is not amenable to a standard definition, that the term is study/investigation-dependent and that the specific meaning of the term should be readily apparent within the context of the subject under discussion.

- DOE indicates that the term "geologic setting" is indirectly defined within the different investigative elements of the SCP (study plans and investigations).

- In its response to the question of the definition of "geologic setting," DOE has indicated that the definition is subject-specific and "the meaning of the term should be readily apparent within the context of the individual investigation." However, in the NRC staff's evaluation of two volcanic-related study plans where definition of the "geologic setting" is appropriate, DOE's definition of the term is not readily apparent. In fact, the term "geologic setting" does not appear within either study plan.

- DOE has indicated (1) that it will "define" geologic setting on a case-by-case basis and (2) that the definition will be based upon the objective of the investigative element (study plan or investigation) under consideration.

- DOE's meaning of "physical domain" is presented in its response to this NRC comment. An expansion of this meaning is also found in NRC Comment 46. Within its response(s) DOE indicates that the term "physical domain"

is not directly related to the term "geologic setting" as used in 10 CFR Part 60.

- DOE has not responded to the NRC's comment regarding the SCP basis underlying the 70 kilometer limit on volcanic activities (a natural system within the geologic setting).

- It is unclear how DOE intends to meet requirements that depend upon the use of the term "geologic setting."

- Closure of this comment must await NRC staff review of the individual investigations (unspecified by DOE) that contain the specific meaning of the term "geologic setting."

- The NRC staff considers this comment open.

Section 8.3.5 Performance Assessment Program

SCA COMMENT 76

It is inappropriate to rely on NRC staff reviews of DOE's work as peer reviews.

EVALUATION OF DOE RESPONSE

- In making this comment, NRC staff was concerned because DOE included a statement about NRC staff review in a paragraph on applications of judgment in post-closure performance assessment and immediately followed it by a statement about the role of peer review. Such a juxtaposition might imply an incorrect view of the staff's role in helping DOE develop its license application. The NRC staff review does not serve the same purpose as peer review in developing a license application.

- In its response DOE agrees that it is inappropriate to rely on the NRC staff for its peer reviews. Further, DOE points out that that the sentence in the cited paragraph merely acknowledges that NRC staff reviews have started and will continue through site characterization and repository development.

- Based on DOE's agreement with this comment, the NRC staff considers this comment closed.

Section 8.3.5.2 Issue resolution strategy for Issue 2.4, pp. 8.3.5.2-1/52

Section 8.3.5.5 Issue resolution strategy for Issue 2.3, pp. 8.3.5.5-1/35

SCA 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 states 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 and when a decision is made to retrieve the waste from the repository, DOE would analyze the retrieval process to identify items important to safety and measures to mitigate or prevent credible accidents. The staff considers that the DOE's response does not adequately address the effects of credible accidents on projected radiological exposures during retrieval operations.

- DOE also states that it is premature to evaluate the effects of potential radiological accidents because (1) the reasons for retrieval, and (2) the conditions under which retrieval would need to be carried out can only be speculated. The staff considers that these reasons do not seem to be appropriate to justify that a radiological consequence analysis for retrieval operations is not needed prior to retrieval. Although staff agrees that precise conditions for retrieval are not known at this time, DOE needs to consider the projected range of conditions to evaluate the effects of potential radiological accidents.

- Progress toward closure of this comment will require DOE to 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 open.

Section 8.3.5.3 Issue resolution strategy for Issue 2.1: During repository operation, closure and decommissioning (a) will the expected average radiation dose received by members of the public within any highly populated area be less than a small fraction of the allowable limits and (b) will the expected radiation dose received by any member of the public in an unrestricted area be less than the allowable limits as required by 10 CFR 60.111, 40 CFR 191 Subpart A, and 10 CFR Part 20.

Regulatory basis for the issue, pp 8.3.5.3-3 to 8.3.5.3-18

SCA COMMENT 78

It can not be determined if all the requirements of 10 CFR Part 20, specifically those in 20.105(b)(1) and 20.105(b)(2), are being considered in the design requirements for the preclosure.

EVALUATION OF DOE RESPONSE

- Comment 78 was intended to assure that DOE would include all the requirements of 10 CFR Part 20, as applicable, in the design requirements for preclosure.
- The DOE response to Comment 78 indicated that only those requirements which affected data needed from the site were presented in detail in the SCP.
- The DOE response to Comment 78 stated that the SCP and the SCP-CDR assume that all design requirements will be considered and that the facility design requirements include 10 CFR 20 as design criteria.
- The NRC staff assumes that this response indicates that all applicable 10 CFR Part 20 requirements, including 20.105(b)(1) and 20.105(b)(2), are being considered by the DOE in the preclosure design.
- The NRC staff considers this comment closed.

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

SCA COMMENT 79

It has not been demonstrated that the test environment used in waste package corrosion tests is fully representative of the repository environment.

EVALUATION OF DOE RESPONSE

- o DOE indicates that the test environments for waste package corrosion tests will evolve as site data and detailed designs become available.
- o The NRC staff considers this comment open.

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113 (Tentative goals for release from the waste packages) p. 8.5.9-19, Para. 3.

SCA COMMENT 80

Some performance goals related to the requirement for substantially complete containment do not appear to be consistent with DOE's revised interpretation of the containment requirement and the intent of the rule.

EVALUATION OF DOE RESPONSE

- DOE considers that the numerical goals stated in this section are consistent with the intent of NUREG-0804 which states "It is expected that ... release during the containment time (will be) limited to a small fraction of the inventory." While this may be true, NUREG-0804 does not give any further amplification of what the performance expectation is that would provide useful guidance to DOE.

- The NRC staff has not defined explicitly acceptable limits for the release of radionuclides during the containment period; however, the staff has an ongoing effort to develop guidance on the meaning of "substantially complete containment" which, when complete, may aid in resolving this issue.

- The NRC staff considers this comment open.

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

Section 7.4.2.6.4 Activities to determine transgranular stress corrosion cracking susceptibility

SCA COMMENT 81

Investigations into the stress corrosion cracking behavior of the container alloys assume that the container surface will be either homogeneously dry or homogeneously wet, but in the corrosion model (7.4.5.4.6), it is stated that "the waste package will most likely not be uniformly wet."

EVALUATION OF DOE RESPONSE

- DOE indicates that as site data and detailed designs become available, it will specify the test environments, activity and test plans to determine transgranular stress corrosion cracking susceptibility for the waste package and so data are not available now. No mention is made of tests to determine corrosion influences due to partial wetting (e.g. any water line or liquid present in crevices/cracks) in a moist environment.

- The NRC staff considers this comment open.

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

Section 8.3.5.10 Issue resolution strategy for Issue 1.5: Will the waste package and repository engineered barrier systems meet the performance objective for radionuclide release rates as required by 10 CFR 60.113?

Section 7.4.5.2 Processes affecting waste package performance.

Section 7.4.5.4 Yucca Mountain Project waste package system model description.

SCA COMMENT 82

There is an inadequate discussion on how performance of the waste package may be verified at the time of license application.

EVALUATION OF DOE RESPONSE

- DOE indicates that details of the studies to address the concerns of this comment will be deferred until Advanced Conceptual Design with the detailed activity plan to be developed in early 1994.
- Details on spent-fuel testing and other studies on full-scale prototypical containers will be provided in future study plans.
- The NRC staff considers this comment open.

Section 8.3.5.9 Issue resolution strategy for Issue 1.4. Will the waste package meet the performance objective for containment as required by 10 CFR 60.113?

Section 7.4.5.4.6 Corrosion model

Section 7.5.4.6 Metal barrier

SCA COMMENT 83

The term "uniform corrosion" is misleading.

EVALUATION OF DOE RESPONSE

- DOE agrees to use the term "general corrosion" instead of the misleading term "uniform corrosion."
- DOE indicates that for general corrosion, the container lifetime will be determined by the highest local rate of general corrosion. The staff accepts this approach.
- The NRC staff considers this comment closed.

Section 8.3.5.9 Containment by Waste Package.

Section 8.3.5.10 Engineered Barrier System Release Rate.

SCA COMMENT 84

The issue resolution strategies and testing programs for design of the waste package (Section 8.3.5.9 of the SCP) and engineered barrier system (Section 8.3.5.10 of the SCP) do not take into account the full range of reasonably likely natural conditions ("anticipated processes and events") that, with current understanding of the site, might be expected to affect performance of these barriers.

EVALUATION OF DOE RESPONSE

- The DOE response references the NRC draft staff technical position on "Guidance for Determination of Anticipated Processes and Events and Unanticipated Processes and Events"; however, the logic presented in paragraph two of the response reflects "unanticipated processes and events," not anticipated processes and events.

- The NRC staff notes that while the draft technical position reflects the present position of the NRC staff concerning the definitions of anticipated processes and events and unanticipated processes and events, discussions are being conducted with EPA staff concerning finalization of 40 CFR 191 with the goal that unified terminology can be incorporated in 10 CFR 60 and 40 CFR 191. Under such conditions the staff may revise its position and allow a probabilistic approach to determination of "anticipated processes and events and unanticipated processes and events".

- Notwithstanding the above, the Yucca Mountain site has an existing stress field which indicates that favorably oriented faults are in a state of incipient failure. When this information is combined with the preliminary data concerning stresses which will be applied from such factors as thermal loading the NRC staff sees no way that--based on the present knowledge--faulting can be considered as a random stochastic variable in space and time. Unless site characterization greatly changes the present understanding of the tectonic conditions at Yucca Mountain, the NRC staff considers faulting as "reasonably likely to occur" and therefore an anticipated process and event which must be considered in determining compliance with the performance objectives of 10 CFR 60.113.

- With respect to DOE's expressed concern about premature inclusion of hypothesized events within the tentative design bases (with resulting increase in lifecycle cost of the waste packages), the NRC staff notes that determination of compliance with 10 CFR 60.112 will require the consideration of unanticipated processes and events. Under such conditions the waste package, engineered barrier system, and the natural system must work together to assure compliance with the overall system performance objective. It may be necessary, therefore, to design for unanticipated processes and events.

- The response references DOE's response to Comment 47 which states that analysis of waste package rupture due to tectonic events will be addressed in Study Plan 8.3.1.8.2.1. The NRC staff has not seen this study plan and Comment 47 remains open until this study plan can be reviewed.

- Study plan 8.3.1.8.2.1 is to provide a link to SCP section 8.3.5.9.4.1, which in turn links to sections 8.3.5.9.3, 8.3.5.10.3.1, and 8.3.5.10.3.5. While these sections, in turn, link to issue 1.1, the conditions under which the tests and analyses reported in 8.3.5.9.3, 8.3.5.10.3.1, and 8.3.5.10.3.5 are being conducted appear quite restricted in comparison to the scenarios being considered under issue 1.1 (SCP Section 8.3.5.13). The NRC remains concerned, therefore, that the tests and analyses described for the waste packages and engineered barrier system do not reflect the full range of potential anticipated processes and events, and as need be, unanticipated processes and events.

- The NRC staff is well aware of the potential increased lifetime cost which would be incurred if faulting is included in the design basis of the waste package and engineered barrier system. The staff is also well aware of the tectonic conditions at Yucca Mountain and considers it prudent for the DOE to consider faulting, as well as other potential anticipated processes and events, in the testing of potential waste package and engineered barrier systems. Following site characterization it may be possible to eliminate faulting from potential design basis conditions but the present site data do not suggest this possibility. The range in faulting parameters, and the potential effects of these parameters on determining compliance with the subsystem performance objectives should be investigated.

- The NRC staff considers it necessary for DOE to consider the effects, as need be, of unanticipated processes and events on the overall system design to assure compliance with the overall system performance objective.

- The NRC staff considers this comment open.

Section 8.3.5.9.1.1.4 Subactivity 1.4.11.4: State of stress in the container

SCA COMMENT 85

The SCP does not take into account temporal changes in the state of stress due to corrosion of the container.

EVALUATION OF DOE RESPONSE

- o DOE indicates that evaluation of local corrosion features will be deferred until detailed designs and performance scenarios are available.
- o The NRC staff considers this comment open.

Section 8.3.5.9.2.2.1 Subactivity 1.4.2.2.1: Assessment of degradation modes in copper-based materials.

SCA COMMENT 86

The basis for degradation modes of copper-base alloys given in the SCP does not appear to agree with scientific literature. Future testing plans may therefore be improperly designed.

EVALUATION OF DOE RESPONSE

- DOE indicates that the degradation modes for candidate copper materials are being surveyed and that test plans would be developed for any promising materials.
- The NRC staff considers this comment open.

Section 8.3.5.9.2.3 Subactivities 1.4.2.3.2. - 1.4.2.3.9. Laboratory Test Plan for Austenitic Materials

SCA COMMENT 87

The possibility that the container may come into contact with dissimilar metals (resulting in galvanic corrosion) is not addressed adequately in this section.

EVALUATION OF DOE RESPONSE

- DOE indicates that the galvanic effects within the engineered barrier system will be evaluated when detailed designs are developed. The response contains no substantive discussion of the DOE approach at the level of detail that would have been expected in the SCP.

- The NRC staff considers this comment open.

Section 8.3.5.9.3.2.7 Subactivity 1.4.3.2.7: Transgranular stress corrosion cracking

SCA COMMENT 88

In the SCP the implication is made that by going from the saturated zone to the unsaturated zone of the repository, the uncertainties with respect to corrosion are reduced.

EVALUATION OF DOE RESPONSE

- DOE indicates that evaluation of the corrosion properties of the waste package in the unsaturated zone will be deferred until site data, detailed designs, and performance scenarios become available.
- The NRC staff considers this comment open.

Section 8.3.5.10 Issue resolution strategy for Issue 1.5: Will the waste package and repository engineered barrier systems meet the performance objective for radionuclide release rates as required by 10 CFR 60.113?

SCA COMMENT 89

Grouts, cements, and organic materials used in the repository may change the local pH of the repository and affect the corrosion of the metal waste containers and the local leach rates of radionuclides from the glass.

EVALUATION OF DOE RESPONSE

- DOE indicates that their testing programs will investigate how the water chemistry is changed by the waste package and other repository materials and how such changes affect the corrosion of the containers and the leaching of radionuclides. However, the staff finds the information to be insufficient to close this comment because the response contains no substantive discussion of the DOE investigations at the level of detail that would have been expected in the SCP.

- The NRC staff considers this comment open.

Section 8.3.5.10 Issue resolution strategy for Issue 1.5: Will the waste package and repository engineered barrier systems meet the performance objective for radionuclide release rates as required by 10 CFR 60.113?

Section 7.4.5.4.5 Waste package environment model

SCA COMMENT 90

The effects of varying oxygen concentration on the corrosion of the metal container are not considered.

EVALUATION OF DOE RESPONSE

- While DOE indicates that the effects of varying oxygen concentration on the corrosion of the metal container will be considered when site data, detailed designs, and performance scenarios are available, the response contains no substantive discussion of the DOE approach at the level of detail that would have been expected in the SCP.

- The NRC staff considers this comment open.

Section 8.3.5.10. Issue resolution strategy for Issue 1.5: Will the waste package and repository engineered barrier systems meet the performance objective for radionuclide release rates as required by 10 CFR 60.113?

P.8.3.5.20-14 (Alternative approaches to be used if the reference approach proves inadequate to contain gas release).

SCA COMMENT 91

Figure 8.3.5.10-3 outlines the various alternatives to be used if the reference approach proves inadequate to contain radionuclide releases. Two approaches are proposed. The first approach proposes alternatives on what can be done on the spent fuel waste form and release rates. One of the alternatives proposed (Alternative 1, gas release) would alter the release rate limit on carbon-14 from EBS under 10 CFR 60.113(b). The second approach proposes alternative container designs as discussed in Section 8.3.5.9. The SCP does not include discussion or consideration regarding how well the alternative containers (e.g. the ceramic-metal system, the bi-metal system and the coating and filler system) can also reduce the gas release of carbon-14 from the EBS.

EVALUATION OF DOE RESPONSE

- DOE indicates that they have not yet projected the release of gaseous carbon-14 from alternative container designs. They believe that instead of modeling such release or of designing containers to contain such release, it would be advisable to determine the impact on human health of carbon-14 releases. Apparently, one of the alternatives being considered by DOE is to seek approval under 10 CFR 60.113(b) for a variation in the allowed release of carbon-14. DOE is also considering an alternative design concept of long-term (greater than 1,000 years) containment. However, while DOE has mentioned possible approaches it may pursue, its response does not provide substantive information about its plans at the level of detail that would have been expected in the SCP.

- The NRC staff considers this comment open.

Section 8.3.5.12 Issue resolution strategy for Issue 1.6: Will the site meet the performance objective for pre-waste-emplacement ground water travel time as required by 10 CFR 60.113?

SCP COMMENT 92

The approach for delineating the boundary of the disturbed zone does not include all physical or chemical properties which will have changed as a result of heat generated by the emplaced radioactive wastes such that the resultant change of properties may have a significant effect on the performance of the geologic repository.

EVALUATION OF DOE RESPONSE

- DOE agrees that the approach for defining the disturbed zone boundary should consider all physical and chemical properties that could change as a result of heat generated by the emplaced waste and that the significance of these changes on repository performance should be ascertained. Further, the processes surrounding the repository are very complex coupled phenomena that will require multi-disciplinary efforts before they are understood. In addition, a review of SCP Section 8.3.5.12 identified a planned activity (Activity 1.6.5.2, Definition of the disturbed zone) which will reevaluate and, if necessary, refine the boundary of the disturbed zone. As described in the SCP, Activity 1.6.5.2 may be an ongoing activity as a result of changes in NRC guidance and in DOE understanding of repository property effects. Therefore, the NRC staff considers this comment closed.

Section 8.3.5.12 Issue resolution strategy for Issue 1.6: Will the site meet the performance objective for pre-waste-emplacement groundwater travel time as required by 10 CFR 60.113?

SCA COMMENT 93

The proposed method for constructing cumulative distribution curves (CDFs) for groundwater travel time by weighting (perhaps subjectively based on peer review) "alternative conceptual models" is theoretically inappropriate and would not provide exhaustive (complete) assessments of groundwater travel time for NRC staff review.

EVALUATION OF DOE RESPONSE

- The NRC recommended that DOE generate, individually, groundwater travel time cumulative distributions for each defensible "alternative conceptual model" for NRC review. It is expected that such a method will converge on "adequate" modeling of the physical systems, processes, and inputs needed for an evaluation of the groundwater travel time performance objective. DOE responded that its present approach for evaluating groundwater travel time is "consistent" with the NRC recommendation. DOE plans independent evaluations of each model configuration and plans to establish "criteria for site-characterization information that would help discriminate between models."

- The NRC staff considers this comment closed.

Section 8.3.5.12 Issue Resolution strategy for Issue 1.6: Will the site meet the performance objective for pre-waste-emplacement groundwater travel time as required by 10 CFR 60.113?

SCP COMMENT 94

Identification of all assumptions about features, events and processes related to the hydrologic system incorporated into the initial modeling strategy for the performance analysis of groundwater travel time is not complete. Initial assessments as to whether these assumptions are technically justified are not presented.

EVALUATION OF DOE RESPONSE

- In response to this comment DOE has provided information based on observation, laboratory studies, numerical experiment, field studies and natural analogs, on what are believed to be essential conceptual elements of the site unsaturated zone hydrologic system. These include:

  1. The system is variably saturated;
  2. The system is both multiphase and multicomponent;
  3. The system domain is heterogeneous;
  4. Unsaturated flow processes are nonlinear;
  5. The process of flow is essentially multidimensional;
  6. Both the process and domain are anisotropic;
  7. Boundary conditions are highly variable in both time and space; and
  8. The flow process is inherently nondeterministic.

- The DOE also indicates that the assumptions used in the initial assessments of regulatory compliance with the groundwater travel time criterion are documented in Lin and Tierney (referenced as Sinnock, et al., 1986 in the SCP). Finally, DOE indicates that all assumptions in the initial modeling strategy require additional support.

- The NRC staff considers this comment closed. The purpose of this comment was not to take issue with any particular assumption embedded in, or omitted from, previous modeling analyses. Rather, the purpose was to underscore the importance of completely and thoroughly outlining assumptions embedded in the performance assessment models to allow DOE to demonstrate that the assumptions made and the considerations omitted from analyses of performance have no substantial effect on the performance of the repository.

Section 8.3.5.13 Total System Performance

SCA COMMENT 95

The underlying methodological logic that is used to develop and screen scenarios and its implementation in the SCP appears to be deficient for the generation of a CCDF representative of total system performance; therefore, this approach is unsuitable for guiding the site characterization program, even if allowances are made for the current lack of knowledge about the site and the expediencies required to develop the site characterization program.

EVALUATION OF DOE RESPONSE

- DOE recognizes that scenario development is an iterative process, stating that DOE "continues to work on scenario development and will do so as long as reasonable questions arise from site investigations or public concern." DOE's response provides some additional discussion of the process that DOE intends to use for scenario development.

- DOE's response suggests a general convergence of views regarding most of the subjects raised by the NRC staff in this comment. However, one significant issue is not addressed in DOE's response -- the NRC staff's recommendation for explicit criteria for development and screening of scenarios. DOE indicates that "project participants" will be requested to add to or subtract from a scenario event tree, apparently based on their subjective judgment of the significance of their additions or deletions. The NRC staff continues to believe that DOE should develop explicit criteria for such additions or deletions.

- The NRC staff considers this comment open. While DOE's views and those of the staff appear to be converging, an interaction is needed to continue progress toward resolution of differences. The NRC staff is particularly concerned about the absence of explicit criteria for scenario development and screening.

Section 8.3.5.13 Issue Resolution Strategy for Issue 1.1: Will the mined geologic disposal system meet the system performance objective for limiting radionuclide releases to the accessible environment as required by 10 CFR 60.112 and 40 CFR 191.13?

Section 8.3.1.3.4 Investigation: Studies to provide the information required on radionuclide retardation by sorption processes along flow paths to the accessible environment

Section 8.3.1.3.5 Investigation: Studies to provide the information required on radionuclide retardation by precipitation processes along flow paths to the accessible environment

SCA COMMENT 96

The Investigations to characterize radionuclide retardation are focused on the determination of a Kd for use in the equations $R_m = 1 + \rho_b K_d/\theta_m$ and $R_f = 1 + \rho_f K_d/\theta_f$, Equations 8.3.5.13-14a and b. It has not been demonstrated in the SCP that the use of these equations to model the complex heterogeneous medium of Yucca Mountain is valid for all expected (i.e., anticipated) states of the natural flow system (i.e., full range of unsaturated and saturated).

EVALUATION OF DOE RESPONSE

- The NRC staff recommended that the geochemistry program demonstrate that Kd's are appropriate for use under the conditions expected at Yucca Mountain or that information is obtained for developing the transport model(s) needed for performance assessment. DOE agrees with the comment, is aware of data needs and data inconsistencies, and believes that the study plans would provide the additional detail sought in the comment.

- NRC considers this comment open. The NRC staff considers that the response does not provide enough information about the planned investigations at the SCP level of detail to close this comment. In order to make progress towards closure, NRC will have to review Study Plan 8.3.1.3.4.1 (Batch Sorption Studies), 8.3.1.3.4.2 (Biological Sorption and Transport), 8.3.1.3.4.3 (Development of Sorption Models), and 8.3.1.3.5.1 (Dissolved Species Concentration Limits).

Section 8.3.5.13 Issue Resolution Strategy for Issue 1.1: Will the mined geologic disposal system meet the system performance objective for limiting radionuclide releases to the accessible environment as required by 10 CFR 60.112 and 40 CFR 191.13?

SCA COMMENT 97

Evidence presented is not adequate to conclude that iodine can be eliminated as an important radionuclide which can be transported in the gaseous phase. As a result, data collection plans are not complete.

EVALUATION OF DOE RESPONSE

- The NRC staff recommended that DOE provide evidence to adequately support the conclusion that iodine can be eliminated as an important radionuclide or expand characterization to include the collection of that needed information. DOE responded by stating that it will evaluate iodine transport in the gas phase using a gas-phase-release event tree. Consequently, the NRC staff considers this comment closed.

Section 8.3.5.13 Total System Performance

SCA COMMENT 98

Weighting alternative conceptual models according to the judgment that they are likely to be correct and using such "probabilities" to weight consequences in the construction of the CCDF is not a conservative estimate of repository performance, nor is it an advisable approach for demonstrating compliance.

EVALUATION OF DOE RESPONSE

- In its response, DOE agrees that weighting alternative conceptual models according to their likelihood of being correct and incorporating such likelihoods into the CCDF characterizing repository performance does not necessarily produce a conservative estimate of repository performance.

- DOE suggests that it could construct a family of CCDF's to demonstrate the impact of uncertainty in conceptual models on repository performance. Such an approach, rather than the combination of such CCDF's as stated in the SCP, has the advantage of providing more information in an accessible fashion to the NRC staff and licensing board.

- If DOE has in fact adopted an approach that does not combine results from alternative conceptual models according to the judgment that they are likely to be correct, the original comment is resolved; however, the DOE response is not a clear commitment to that effect.

- The DOE response also raises a new issue. DOE states that it would use a Bayesian approach to eliminate alternative conceptual models from consideration. Although Bayesian statistical approaches have been used extensively in recent years to address issues of nuclear safety, the NRC staff does not agree that posterior probabilities should be used to eliminate conceptual models no longer consistent with the updated information. The staff would prefer hypothesis testing conducted in the traditional context of the scientific method; i.e. the site characterization program should attempt to acquire data from critical experiments that will disqualify incorrect alternative concepts. The application of Bayes' theorem to choose among alternative conceptual models has theoretical and practical difficulties; these include (1) a degree of arbitrariness in determining prior probabilities and likelihood functions and (2) the possibility that no posterior probability associated with a set of alternative conceptual models will be large enough to rule out the other alternatives.

- The NRC staff considers this comment open.

Section 8.3.5.13 Total System Performance

SCA COMMENT 99

For some scenario classes in which a particular release mode is thought to dominate or, at least, dominate for a particular time period, the consequences that are calculated may not be adequately represented unless all of the release modes are quantified, especially the residual part of the inventory continuing to participate in the nominal or undisturbed mode(s) of release. Premature and inappropriate limiting of the consequence analysis in this way may distort the performance allocation process so that insufficient priority is placed on some data or important data acquisition activities may be omitted from site characterization.

EVALUATION OF DOE RESPONSE

- NRC commented that DOE might be distorting the performance allocation process by ignoring undisturbed release modes when considering dominant release modes. NRC recommended that all appropriate modes of release should be included in the consequence analysis unless they can be eliminated as being insignificant. Furthermore, all modes of release should be calculated, and the performance allocation process should include all modes of release.

- DOE replied that it agreed with all NRC recommendations and believes that they were already incorporated into the planned work. They stated that disruptive scenarios are treated as perturbations to the nominal cases. In making the comment the NRC staff considered that the SCP did not reflect this approach. Accordingly, the issue will be resolved when DOE provides the NRC staff with information indicating how various release pathways enter into performance allocation and the calculations of the CCDF.

- The NRC staff considers this comment open.

Section 8.3.5.13 Total System Performance

SCA COMMENT 100

There are two problems with the sequences for faulty waste emplacement (pp. 8.35.13-32 to 33): (1) sequences for faulty waste emplacement establish the initial condition for the repository at time of closure and should not be included in the set of scenarios, and (2) the sequences are so limited, it is not clear that the site characterization program will acquire the data to analyze the likelihood and consequences of such initial defects.

EVALUATION OF DOE RESPONSE

- DOE does not respond directly to the NRC staff's suggestion that faulty waste emplacement be treated as an initial condition rather than as an event to be included in a scenario analysis.

- The NRC staff considers this comment open.

Section 8.3.5.13 Total System Performance

SCA COMMENT 101

Equation 8.3.5.13-21, which is used to estimate "the partial performance measure for the jth scenario class involving releases along the water pathway" [sic; see Comments 95 and 99 for an explanation of why it is not appropriate to define scenario classes in terms of release mode] appears to have been derived on the basis of inconsistent assumptions and may be in error.

EVALUATION OF DOE RESPONSE

- DOE replies that the assumptions used in deriving Eq. 8.3.5.13-21 in the SCP are valid when the fractional release rate r_i is valid. It points out that the expression for S_i on page 8.3.5.13-70 was incorrect, and gives the correct expression from a later publication than the one originally cited. The main point DOE makes in its reply, however, is that the model embodied in the SCP is preliminary, included for illustration only to make the theoretical discussion clearer.

- It is the NRC's staff understanding from its review of the SCP, that the model was also included in the discussion for the purpose of deriving parameter goals for performance allocation. Consequently, the NRC staff considers that this comment will be closed when the appropriate changes are made to the performance allocation.

- The NRC staff considers this comment open.

Section 8.3.5.13 Total System Performance

SCA COMMENT 102

The model for Ross sequences number 10 (p. 8.3.5.13-29), 14 and 15 (p. 8.3.5.13-30) seems to be at variance with the hydrologic model of flow at Yucca Mountain; because (as in this case) the basis for developing scenarios to guide the site characterization program appears to be inconsistent, site characterization may fail to provide the information needed for licensing.

EVALUATION OF DOE RESPONSE

- In DOE's response to Comment 95 (referred to in the response to this comment), the DOE states that "[t]he statement that 'scenarios should be limited to descriptions of the external constraints, in time, on the system' [from NRC staff Comment 95] is not consistent with DOE's use of the term 'scenario.'"

- Under DOE's definition of a scenario, the conceptual models for vertical and lateral flow conditions may be in effect at the same time, i.e., within the same scenario. DOE feels that to develop scenarios from only those sequences incorporating the current conceptual model of infiltration and flow at Yucca Mountain would place undue severe restrictions on the event and processes lists and therefore on DOE's overall scenario development methodology.

- The NRC staff considers that alternative conceptual models, e.g., only vertical flow downward versus vertical plus lateral flow at the site, should be separated from the events and processes used to develop the scenarios. Further, a systematic exhaustive approach to scenario development should be followed separately for individual alternative site conceptual models.

- The NRC staff considers this comment open. The staff considers that an interaction is needed in order to come to a resolution regarding a mutually acceptable definition for a "scenario" and methodology for scenario development.

Section 8.3.5.1 Total System Performance

SCA COMMENT 103

Ross sequence numbers 59-62 and 64-69 appear to characterize either anticipated conditions or alternative conceptual models, rather than scenarios.

EVALUATION OF DOE RESPONSE

- The NRC staff commented on the DOE characterization as scenarios of some anticipated conditions or alternative conceptual models. The NRC staff recommended that DOE include anticipated conditions and alternative conceptual models in its plans to characterize the site, and not call them scenarios. DOE responded that, in using event trees to construct scenarios, DOE defines a scenario as a path through the tree from initiating event to radionuclide release to the water table. Consequently, the scenarios would include these types of processes and events, even if they differed from scenario to scenario.

- It is not clear that the DOE approach is consistent with probability theory or the NRC staff interpretation of 40 CFR 191. The NRC staff interprets 40 CFR 191 as incorporating parameter uncertainty and future states uncertainty into the CCDF. Attempts to include other uncertainties may confound decisions regarding acceptability of the repository.

- The NRC comment remains open. It should be addressed in a future NRC/DOE interaction.

Section 8.3.5.13 Total System Performance

SCA COMMENT 104

The Ross sequences appear to be based entirely on spent fuel as the waste form; since these sequences presumably form a basis for the site characterization program, it is not clear that important scenarios that may be peculiar to vitrified HLW have not been omitted.

EVALUATION OF DOE RESPONSE

- The NRC staff commented that DOE based its scenarios on spent-fuel waste form only, and neglected any ramifications of vitrified HLW. DOE replied that it will consider vitrified HLW within the context of its general scenario selection procedure that considers all important processes.

- The NRC staff considers this comment open because DOE did not respond directly to it in terms of definite scenarios and other appropriate augmentation of the site characterization program. Closure can occur if such augmentation is provided in DOE's iterative performance assessment and semiannual SCP Progress Reports.

Section 8.3.5.13 Total System Performance

SCA COMMENT 105

Although DOE may incorporate material by reference in the licensing application and although scenarios already eliminated may not need to be treated in calculating the CCDF in the license application, sufficient data, and analyses, or justification should be accumulated during site characterization to substantiate the decision to eliminate these scenarios.

EVALUATION OF DOE RESPONSE

- In its response, DOE agrees that the SAR will need extensive discussions about scenario selection. DOE refers to the discussion on technical support documentation (TSD) in the response to Comment 1 which, in the third paragraph on page 18 describes the TSD as consisting of technical reports and licensing documents that will synthesize data gathered in SCP studies and compile and interpret information acquired about the site. Also, in the discussion in Section 8.3.5.13 of the SCP, DOE refers to the iterative nature of the scenario screening process. The response relies primarily on the iterative nature of the process. As site data are acquired, updated models would indicate priority data needs and detailed reasons for eliminating scenarios.

- The point of NRC's comment lies in its basis as well as its recommendation. There is no reason to think that an iterative process would necessarily bring back scenarios that were eliminated at an early stage. Care must be taken in eliminating scenarios in a systematic manner that allows the data to be accumulated during site characterization to justify the decision to eliminate the scenarios.

- The NRC staff considers this comment open. Discussion at an interaction on scenario identification and screening would, in part, focus on this issue and would be a first step in bringing the issue to closure.

Section 8.3.5.13 Total System Performance

SCA COMMENT 106

There appears to be a missing coupling term in equation 8.3.5.13-12B; this equation is the primary basis for calculating liquid-phase radionuclide transport to the accessible environment.

EVALUATION OF DOE RESPONSE

- DOE acknowledged that the SCP was in error, and that the missing term should be included as stated by the NRC staff. However, DOE also states that the discussion following the equation in error did not depend on the omission, so no changes to site characterization are necessary. The NRC staff disagrees. It is the NRC staff's view that the missing term should have led to entries in the Hypothesis Testing Table that are not there and should have affected the performance allocation program.

- The NRC staff considers this comment open.

Section 8.3.5.13 Total System Performance

SCA COMMENT 107

Although the introduction of a waiting time in equation 8.3.5.13-24 may, in general, be acceptable from a theoretical viewpoint, care must be taken to assure a correct implementation of the concept, both in generating an empirical CCDF and in approximating performance for purposes of guiding site characterization.

EVALUATION OF DOE RESPONSE

- In the response, DOE first clarifies that the "waiting time" is intended to be a random variable, quoting the statement on page 8.3.5.13-67 that, with certain exceptions, "all the variables appearing on the right-hand side of the Equation 8.3.5.13-21 may be regarded as random variables." Even so, it is stated that Equation 8.3.5.13-21 is not intended to be a final model for releases to the accessible environment.

- DOE briefly addresses the problem of determining the probability distribution for the occurrence of geologic events. It is stated that a Poisson approximation would be made only if it were justified by available information. Further, it is stated that there probably would be no waiting time for alternative conceptual models and undetected features.

- The NRC staff considers that its concerns regarding justification of values for waiting times, if used, have been understood and addressed.

- The NRC staff considers this comment closed.

Section 8.3.5.13 Total System Performance

SCA COMMENT 108

The use of the EPPM (expected partial performance measure) to screen scenarios and to establish goals for the performance allocation used to guide site characterization may be justified on a theoretical basis, but does not appear to be appropriately implemented in the SCP.

EVALUATION OF DOE RESPONSE

- DOE states that "[the] attainment of a performance allocation goal does not guarantee compliance. In the absence of site characterization data, the allocations are based on reasonable expectations that, if met, the allocations are likely to lead to a successful demonstration of compliance."

- In the SCP discussion of performance allocation, the overall licensing strategy is defined as "the basis for current DOE plans to show compliance with regulatory requirements." Performance allocation goals, in turn, are assigned by DOE using values consistent with the licensing strategy for the issue involved. In light of this, the NRC staff considers that the performance allocation goals should be chosen so that, given the right conditions, meeting these goals should guarantee compliance with the regulations.

- DOE states that, although some EPPMs are greater than 0.01 in Table 8.3.5.13-9, this is not an indication that the site will fail. DOE expects all EPPMs will be smaller than their table values. Additionally, DOE does not see the need to check the EPPM contribution of all omitted scenario classes because the condition such that the EPPM sum for all scenarios is less than 0.01 is only a sufficient condition.

- The NRC staff considers that the use of the EPPM and Equation 8.3.5.13-9 have been misapplied in the performance allocation table for Issue 1.1 (SCP Table 8.3.5.13-8) as stated in the comment. It is not clear to the NRC staff how the formulation of Equation 8.3.5.13-9 was applied to Table 8.3.5.13-8.

- The NRC staff considers this comment open.

Section 8.3.5.13 Total System Performance

SCA COMMENT 109

Coupling times for the transfer of mass (radionuclides) between matrix and fracture flow is repeatedly cited as a key factor in determining the appropriate model for radionuclide transport at Yucca Mountain, yet alternative models depending on the nature of the coupling do not appear to be treated in the hypothesis testing tables.

EVALUATION OF DOE RESPONSE

- DOE considers that neither the models of strong vs. weak matrix/fracture coupling nor the various models of matrix/fracture coupling times mentioned in the SCP (Wilson-Dudley, Rasmussen-Neretnieks, and Sudicky-Frind) can be categorized as distinct conceptual models. The NRC staff disagrees (see for example definition of conceptual model on page 8.3.5.20-7 in the SCP), noting that the use and application of any of these models and equations is directly dependent upon which particular conceptual model of flow is operative at Yucca Mountain. This obviously can have an important effect on total system performance at the site.

- DOE states that "[t]he key question, as discussed in the [SCP], is whether there are surface effects that limit the ability of contaminants to diffuse from the fractures into the matrix." The NRC staff considers that the question is not only are these surface effects present, but if so, then how do they affect the diffusion of radionuclides from fractures into the matrix and therefore the overall release from the site.

- DOE states that the present testing program outlined in the SCP will be able to measure the matrix/fracture coupling. This view however does not allay the concern of the NRC staff expressed in this comment: that the testing program will be unable to determine the coupling constants on the temporal and spatial scales necessary.

- The NRC staff considers this comment open.

Section 8.3.5.13 Total System Performance

SCA COMMENT 110

The response to CDSCP comment 90 indicates that human intrusion is intended to be left out of the calculation of the CCDF, but the SCP text is unclear as to how human intrusion will be handled.

EVALUATION OF DOE RESPONSE

- DOE's response indicates neither acceptance of the NRC staff's interpretation of the requirements of EPA's HLW standards nor any concrete proposal by DOE for evaluating the significance of potential human activities. Instead, DOE indicates that "meetings and other interactions" between DOE and NRC are needed.

- The NRC staff is willing to meet with DOE on this subject. If DOE disagrees with the standards (as appears to be the case), then it should raise the issue with EPA as the standards are being revised.

- The NRC staff considers this comment open.

Section 8.3.5.13 Total System Performance

SCA COMMENT 111

Numerous inconsistencies exist in the SCP section on Total System Performance

EVALUATION OF DOE RESPONSE

- Although issuance of updates to the SCP addressing inconsistencies in that document, as recommended in the SCA, will not be produced, the response generally acknowledges the noted inconsistencies.
- The NRC staff considers this comment closed.

Section 8.3.5.13 Total System Performance

SCA COMMENT 112

There is a gap in the discussion of the treatment of state variables as constants or as random variables.

EVALUATION OF DOE RESPONSE

- Although the DOE response addresses the logical gap in the discussion, it does not satisfy the NRC recommendations.

  (1) Since the "coefficient of variation" (CV) is the standard term for the ratio of a random variable's standard deviation to its mean, this term should be used.

  (2) Apparently, there are two conditions for treating a state variable as a constant: (i) if the CV is very small or (ii) if the "results of a calculation" are not sensitive to changes in the state variable. The first condition is explicitly stated but the second condition must be inferred from the last sentence in the third paragraph. Since condition (i) implies condition (ii), it should be explicitly stated that condition (ii) is the defining criterion. Furthermore, "results of a calculation should be replaced by "performance measure" and some attempt should be made to define what is meant by "not sensitive."

  (3) Once the conditions for treating a state variable as a constant are clearly stated, it should be explicitly stated that a state variable which fails to satisfy these conditions must be treated as a random variable. This will serve the purpose of treating all ambiguous state variables as random variables, thus preventing a situation where a state variable with a significant contribution to the uncertainty of a performance measure is treated as a constant.

- The NRC staff considers this comment open.

Section 8.3.5.13 Total System Performance

SCA COMMENT 113

The definition of the unit step function is not consistent with the definition of the CCDF.

EVALUATION OF DOE RESPONSE

- Although DOE agrees that it would be "more consistent" to define the unit step function as stated in the NRC recommendation, DOE does not state whether or not it will change its definition of the unit step function. If DOE does not change its definition, then the definition will remain inconsistent with the definition of the CCDF on page 8.3.5.13-5 and might lead to ambiguity in determining the regulatory compliance of the site.

- In the second sentence of its response DOE seems to imply that the definition of the unit step function will have "no impact on determining the regulatory compliance of the site." This is not correct. For example, suppose that $M < 1.0$ with probability 0.8 and $M = 1.0$ with probability = 0.2. Since

  $$Pr(M > 1.0) = Pr(M > 10.0) = 0,$$

  the site satisfies the containment standard given by equation 8.3.5.13-2. However, if the definition of $u(X)$ given on page 8.3.5.13-9 is used, then $G(1.0) = 0.2$ and the containment standard is <u>not</u> satisfied.

- The NRC staff considers this comment open. A step toward closure may be inclusion of this topic for discussion at a future NRC-DOE interaction on the generation of the CCDF.

Section 8.3.5.13 Total System Performance

COMMENT 114

The term "independent" is incorrectly used instead of the term "mutually exclusive."

EVALUATION OF DOE RESPONSE

- o DOE agrees that the comment is correct.
- o In light of DOE's agreement, the NRC staff considers this comment closed.

Section 8.3.5.13 Total System Performance

SCA COMMENT 115

There is an incorrect statement that the CCDF can be expanded in terms of scenario classes as in Figure 8.3.5.13-2 only if the entities comprising the scenario classes are statistically independent.

EVALUATION OF DOE RESPONSE

- Currently, DOE is not planning to revise the SCP, but proposed a paragraph for addition to the SCP should it be updated in the future. The suggested paragraph (denoted by PAR 1) for inclusion on page 8.3.5.13-13 is almost correct when considered by itself (see below), but it should be inserted at a different place in the text, and the text needs additional modification. First, PAR 1 should be inserted after the paragraph beginning on the bottom of page 8.3.5.13-13 and continuing on page 8.3.5.13-14 (denoted by PAR 2), not before. Since PAR 2 deals with two-state alternative models based on independent objects and since PAR 1 deals with a generalization of this framework, PAR 1 should follow PAR 2. Second, the phrase "provided that they are statistically independent entities" in PAR 2 should be changed to indicate that statistical independence is not a necessary condition but rather a special case.

- The next to last sentence of PAR 1 implies that the order of occurrence of E^1 and E^2 is a further complication; in fact, the example is based on E^1 occurring, if it does occur, before E^2. A suggested replacement is as follows: "Even more complicated situations may arise, for example, where sometimes E^1 precedes E^2 and sometimes E^2 precedes E^1." Also the term "dependencies" should be used instead of "correlation," as it is the more general term. (It is possible for two events to be dependent but uncorrelated.)

- Following PAR 1, it should be noted that a model based on dependent objects presents additional complications in estimating the conditional probabilities.

- The NRC staff considers this comment open, because as explained above, the proposed resolution is incomplete.

Section 8.3.5.14 Individual Protection

SCA COMMENT 116

The strategy for issue 1.2, Chapter 8.3.5.14, incorrectly assumes that if there is no significant source of ground water at the Yucca Mountain site, then all environmental pathways for individual exposure related to radionuclides borne by groundwater are precluded.

EVALUATION OF DOE RESPONSE

- DOE intends to defer their response to this comment until a new EPA standard (40 CFR Part 191) is issued. Sufficient information should then be available to DOE to formulate a new resolution strategy as recommended by the NRC staff in the SCA.

- EPA released another "working draft" in May, 1991, but the NRC staff estimates that promulgation of the final standard may be as much as 2 years later.

- Given these assumptions, it would be mid-1993 before the NRC staff can expect a response from DOE. The NRC staff considers this comment open. Closure will depend on the review of DOE's eventual response.

Section 8.3.5.14 Individual Protection

SCA COMMENT 117

The discussion of individual exposure through the gaseous pathway indicates that "residence time" of carbon-14 in the overburden is required, but the discussion of planned activities and information needs does not indicate that the advective and diffusive flow rates of radionuclide transport will be obtained; without these fundamental quantities, information on retardation will be of no use and calculation of residence time will be impossible.

EVALUATION OF DOE RESPONSE

- NRC commented that although the need to determine individual exposure through the gaseous pathway indicates that "residence time" of C-14 in the overburden is required, the SCP does not indicate that specific activities to gather necessary information would be performed. DOE replied that, while it was true that there were no specific activities to collect data on advective flow of gases for the post-emplacement phase, there were study plans in place to collect data for modeling gas movement in the unsaturated zone for the pre-emplacement phase. DOE also states that data necessary for many of the parameters needed for post-emplacement calculations of C-14 transport would be provided by other planned investigations. In addition, several other investigations targeted to understanding unsaturated water flow would provide additional information needed.

- This comment is open for several reasons:

  1. The study plan to which DOE refers is not yet available.

  2. The pre-emplacement study seems to be geared more to modeling of inert gas (e.g., air, water vapor), rather than transport of reactive substances such as C-14. While the gas flow calculation is a necessary step in the calculation of transport of C-14, it is not sufficient. Additional data on the complicated behavior of C-14 under post-emplacement conditions will also be needed.

  3. The comment recommended that performance allocation be modified to address this issue, but DOE did not respond to this recommendation.

- Closure of this comment depends on NRC staff review of the referenced study plan and the semiannual SCP Progress Reports.

Section 8.3.5.16 Issue resolution strategy for Issue 1.7: Will the performance-confirmation program meet the requirements of 10 CFR 60.137?

Table 8.3.5.16-1

Table 8.3.5.16-2

SCA COMMENT 118

The monitoring and testing activities listed in Tables 8.3.5.16-1 and 8.3.5.16-2 should include long term in situ and long term laboratory waste package activities.

EVALUATION OF DOE RESPONSE

- DOE states that "[t]he ultimate configuration of an Exploratory Shaft Facility will not restrict the ability of in situ testing to be carried out over long periods." DOE then states that planning for a performance confirmation program is premature.

- The NRC staff disagrees with DOE's assertion of prematurity. 10 CFR 60.140 requires that the performance confirmation program be started during site characterization. 10 CFR 60.142(b) requires that the testing be initiated as early as practicable.

- DOE states that the scope of confirmatory testing is dependent on "the degree of reasonable assurance necessary" and on the "extent demonstration of reasonable assurance can be deferred to the amendment to close."

- The NRC staff has a different understanding of the nature of the licensing decisions required by 10 CFR Part 60. 10 CFR 60.31 requires a demonstration of "reasonable assurance" before construction of a repository may be authorized. The purpose of the performance confirmation program of Subpart F of Part 60 is not to permit deferral of a demonstration of safety. Rather, the purpose is to confirm that actual long-term performance measured in situ and in laboratory tests conforms to the projections upon which earlier licensing decisions were based.

- The NRC staff considers its original comment open. Moreover, the staff considers that DOE has opened a new issue in its response -- DOE's view that a demonstration of safety can be deferred until repository closure.

Section 8.3.5.16 Issue resolution strategy for issue 1.7, pp.8.3.5.16-1/10

SCA 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

- o 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.

- o The broad general response essentially defers closure of the comment to the future. It states that the "Plans for the performance confirmation program have not yet been developed to the level of detail requested by the comment." The general response also refers to the DOE's response to Comment 118 in which DOE adds that "Detailed planning for the data needs of a 10 CFR 60 Subpart F performance confirmation program ... is premature at this time." DOE's response further states that "A strategy document to describe the procedure that will be followed to develop these details is forthcoming."

- o Staff evaluation of the itemized DOE responses to the Basis of Comment 119 is as follows:

  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 staff agrees with this position. However, the NRC concern deals specifically and explicitly with performance confirmation testing 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." Staff considers that DOE has not provided enough details to establish this position.

  3. The tables referenced in the DOE's response list "monitoring and testing activities identified as starting during site characterization and being used for performance confirmation." Based on review of this list, the staff considers this portion of the 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.

Also, the description of the heated room test in SCP Section 8.3.1.15.1.6.5 starts with the statement that "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.

5. The tables referenced in the DOE's response list "tests and activities to be continued beyond site characterization." The staff considers this portion of the concern closed.

6. Whereas the NRC concern is expressed quite broadly, i.e., dealing with "... various environmental conditions ...," the DOE's response appears to focus narrowly on "The effect of time at elevated temperatures ...." It is not clear whether the plans for investigation of the effects of variable environmental conditions on mechanical properties are as broad as stated in SCP Section 8.3.1.15.1.3.2, or, rather, are limited to study thermal effects only.

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." The NRC staff considers that DOE should initiate long-term in situ and laboratory waste package tests during site characterization. Therefore, a plan for such activities should be part of the site characterization plan or included in other planning documents early in site characterization (see also the NRC staff evaluation of DOE's response to SCA Comment 118).

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." The staff will review the mentioned documents, when provided by DOE, to ascertain the adequacy of DOE's position on this issue.

- Progress toward closure of the concern expressed in this comment may be accelerated by the "NRC-DOE interaction" referred to in DOE's response.

- Further progress toward closure of this comment will require review of the various plans and documents referred to in DOE's response.

- The NRC staff considers this comment open.

Section 8.3.5.20 Analytical Techniques Requiring Significant Development

SCA COMMENT 120

The SCP correctly notes the importance of model and code validation for evaluating repository acceptability, but lacks an adequate description of the plans for completing such validation. Many potential validation studies require long lead times for planning and execution, and some may be impossible to carry out after the site has been disturbed by characterization and development activities.

EVALUATION OF DOE RESPONSE

- DOE's response says that DOE is developing "a general validation strategy, which will be consistent with the existing SCP." As noted in the NRC staff's evaluation of DOE's response to Comment 56, model validation can be accomplished only by first developing a validation strategy and then by designing and carrying out experiments to execute that strategy. DOE's apparent attempt to conform a validation strategy to the existing SCP may result in an inadequate validation strategy, test information inappropriate for model validation, or both.

- The NRC staff considers this comment open pending its review of DOE's validation strategy.

Section 8.4.2.1.2 Principal data needed for preclosure performance evaluations and design-data needed for underground facility design, pp.8.4.2-14/15

SCA COMMENT 121

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

EVALUATION OF DOE RESPONSE

- DOE's response indicates that discontinuous rock deformation (secondary faulting) is not a credible design consideration. Since DOE has not completed its characterization of the displacements and slips from secondary faulting, the NRC staff considers that DOE has not established that secondary faulting is not credible and need not warrant a consideration in design.

- DOE's response further states that, "..., it is appropriate to define the seismic design basis in terms of peak motions." However, SAND85-7104 (p. 22) states "...dynamic instability of rock openings is a problem in low-cycle fatigue. Thus, duration of the vibratory motion, in particular the duration of frequency components with significant strain amplitudes, may affect the potential for damage to openings." SAND85-7104 (p. 22) further states that, "The use of a time history with a computer model in final design would automatically incorporate duration into the evaluation." Therefore, the NRC staff considers that the design basis motion should be prescribed in terms of full-time histories of acceleration and velocity.

- DOE's response also indicates that the present seismic design basis for the Exploratory Shaft Facility is described in detail in the Exploratory Shaft Seismic Design Basis Working Group Report, SAND88-1203. This report recommends a design basis for the ESF to be .3 g peak ground acceleration which is expected to have a return period of about 1000 years. The NRC staff finds that DOE has not sufficiently justified the adequacy of this design basis in SAND88-1203 or in the SCP. The Bare Mountain fault at about 18 km from the site could generate 0.4 g acceleration at the site, while other Quaternary faults closer to the site may generate even higher peak ground acceleration.

- The referenced report SAND88-1203 considers that the exploratory shaft liners need not be designed as "important to safety." However, YMP/90-55, p. 8, lists ESF lining as a Q-list item.

- Progress toward closure of this comment will require DOE to provide an ESF design basis which is defensible and supportable on the basis of the importance of the facility and in situ seismic conditions.

- The NRC staff considers that DOE has not provided a sufficient response to this comment and therefore this comment is considered open.

REFERENCES

Subramanian, C.V., J.L. King, D.M. Perkins, R.W. Mudd, A.M. Richardson, J.C. Calovini, E. Van Eeckhout, and D.O. Emerson, 1990. Exploratory Shaft Seismic Design Basis Working Group Report, SAND88-1203, Sandia National Laboratories, NM.

URS/John A. Blume & Associates, Engineers, 1986, Ground Motion Evaluation at Yucca Mountain, Nevada, With Applications to Repository Conceptual Design and Siting, SAND85-7104, Sandia National Laboratories, Albuquerque, NM.

U.S. Department of Energy, 1990, Q-List, YMP/90-55, Yucca Mountain Project Office, Las Vegas, NV.

Section 8.4.2.2.2.3 Basis for surface-based testing construction controls, pp. 8.4.2-80/87

SCA 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, is the selection of dry drilling or 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

- o 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 the SCP Progress Reports.
- o Progress toward closure of this comment will require DOE to submit the SCP Progress Reports addressing the issues of acceptability of the dry coring method.
- o The NRC staff considers this comment open.

Section 8.4.2.3.6.2 Potential for construction and operations interference with testing

Section 8.4.3.2.5.3 Potential impacts to the site from construction of the exploratory shafts

SCA COMMENT 123

The effects of ventilation of the exploratory shafts and the underground testing rooms may have been underestimated in the evaluation of the potential interference with testing and the potential for irreversible changes to baseline site conditions; also, there is not an adequate analysis of the effects of ventilation in the ESF on the ability of the site to isolate waste.

EVALUATION OF DOE RESPONSE

- The response points out that the shaft will be lined with poured concrete. One purpose of the concrete liner is to isolate the rock from the ventilation air. The analyses in the SCP cited by the SCA to address this issue are for an unlined shaft, a condition which is thought to be worse than for the lined shaft. However, as stated in DOE's response, "Ventilation air in shafts can cause evaporation or drying of the rock behind the liner." Also the cold joints in the concrete liner will allow water to seep through the liner and be evaporated by the ventilation air.

- Since the analysis in the SCP is not necessarily applicable to the situation questioned, since the response is equivocal regarding whether the concrete liner mitigates the effects of ventilation on the site, and since the issue of secondary effects of ventilation on baseline conditions (e.g., geochemistry) was not addressed, the NRC staff considers this comment open.

Section 8.4.3.2.1.1 Water infiltration from the surface, (3) Water accumulation in the exploratory shaft, p. 8.4.3-10/11

SCA 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

- o DOE's response adequately addresses statements made in NRC's bases for this comment. DOE commits to evaluating the environmental conditions and scenarios affecting drainage, reporting the evaluations in technical support documents, and summarizing them, as appropriate, in Site Characterization Progress Reports.
- o The NRC staff considers this comment closed.

Section 8.6.4.1 Quality Assurance before Site Characterization

SCA COMMENT 125

This section states that data was gathered during site exploration from 1977 to 1986 which may be used for characterization and to support a license application. It further states that if any data is identified as primary information in support of items and activities important to safety or waste isolation, the data will be qualified against the current QA program on a case-by-case basis in accordance with approved administrative procedures incorporating the guidance provided in the U.S. Nuclear Regulatory Commission's "Generic Technical Position on Qualification of Existing Data for High-Level Nuclear Waste Repositories," NUREG-1298, 1987.

DOE has not identified the existing data that will be used in the licensing process and needs to be qualified, nor have they submitted the procedures which will be used to qualify existing data.

EVALUATION OF DOE RESPONSE

- In October 1990, DOE submitted Yucca Mountain Project Administrative Procedure (AP) 5.9Q "Qualification of Data or Data Analyses Not Developed Under the Yucca Mountain Project Quality Assurance Plan," Revision 1 dated July 5, 1990, to answer the staff's questions concerning the qualification of existing data. The staff has reviewed AP-5.9Q for conformance with the NRC Generic Technical Position on Qualification of Existing Data for High-Level Nuclear Waste Repositories, NUREG 1298 and finds it acceptable.

- DOE has indicated that identification of existing data that requires "qualification" by the process described in AP-5.9Q will only be made during site characterization data gathering and analysis. The NRC will be informed at that time, and the staff will evaluate the actual compliance with AP-5.9Q.

- The NRC staff considers this comment closed.

Section 8.6.4.2 Quality Assurance During Site Characterization

Section 8.3.5.5 Preclosure Performance

SCA COMMENT 126

The lists of items and activities covered by the 10 CFR Part 60, Subpart G quality assurance programs are incomplete and the analysis provided for their identification is non-conservative in some areas. (This is the same as Comment 106 on the CDSCP).

EVALUATION OF DOE RESPONSE

- In October 1990, DOE submitted three documents - "Q-list" YMP/90-55; "Quality Activities List," YMP/90-56; and "Project Requirements List," YMP/90-57, all Revision 0 and dated July 24, 1990. DOE has noted that the lists were created using a conservative basis with items and activities subject to change upon additional analysis and sufficient justification.

- The NRC staff has reviewed these three documents and found them acceptable with the understanding that changes will occur prior to any licensing submittal as more information becomes available and the analyses become more complete.

- The NRC staff considers this comment closed.

Section: Design Acceptability Analysis, Chapter 3: Assessment of Alternative Shaft Locations

SCA COMMENT 127

The process used to integrate all available technical data into decisions regarding shaft location appears to have been inadequate because an apparent lack of data integration raised concerns about the suitability of shaft locations and about a process that has resulted in a possible violation of the criteria specified in the Design Acceptability Analysis (DAA) for set-back distances from faults.

EVALUATION OF DOE RESPONSE

- The response to this comment indicates that the concerns expressed were addressed by the Technical Assessment Review (TAR) to assess the "Geologic and Geophysical Evidence Pertaining to Structural Geology in the Vicinity of the Proposed Exploratory Shaft" (YMP/90-2, 1990). Also indicated was the fact that the results of ongoing studies, namely, the Exploratory Shaft Facility Alternatives Study and the Calico Hills Risk/Benefit Analysis, may result in the relocation of the exploratory shafts and the consequent disappearance of the need for implementation of the recommendations of the TAR.

- DOE revised its process for controlling the ESF design and incorporated the revised process into DOE administrative procedures.

- The staff considers that the recommendations of the TAR may need to be implemented for any ESF shaft or ramp alternative selected on the basis of the ESF Alternatives Study.

- Closure of this comment must await DOE's completion of, and NRC staff evaluation of, the referenced documents.

- The NRC staff considers this comment open.

Section: Design Acceptability Analysis

SCA COMMENT 128

Several applicable 10 CFR 60 requirements have not been considered in evaluating 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 did not 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.

- Progress toward closure of this comment will require DOE's submittal of the ESF Alternatives Study for NRC staff review. The NRC staff considers this comment open.

Section: Design Acceptability Analysis

SCA 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.

- DOE's response to comment 128 indicates that 11 requirements, which NRC has noted as being applicable to the ESF design in that comment, are being considered in the ESF Alternatives Study and will be considered in future design activities.

- Because the DOE's response has clarified the differences in the various listings of applicable 10 CFR Part 60 requirements in the DAA and DOE has agreed to consider all applicable 10 CFR Part 60 requirements in future design activities; the NRC staff considers this comment closed.

Section: Design Acceptability Analysis

SCA 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 raises 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.

- Progress toward closure of this comment will require DOE's submittal of the ESF Alternatives Study for NRC staff review.

- The NRC staff considers this comment open.

Section: Design Acceptability Analysis

SCA 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.

- The NRC staff considers this comment closed.

Section: Design Acceptability Analysis

SCA 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.

- Progress toward closure of this comment will require DOE's submittal of the ESF Alternatives Study for NRC staff review.

- The NRC staff considers this comment open.

Section: Design Acceptance Analysis

SCA 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 NRC staff considers this comment closed.

Section 8.3.1.17.4.9.3 Activity: Evaluate variations in the nature and intensity of Quaternary faulting within 100 km of Yucca Mountain through morphometric and morphologic analysis

Section 8.3.1.17.4.12.1 Activity: Evaluate tectonic processes and tectonic stability at the site

SCA QUESTION 1

The SCP lists many surficial mapping projects, some of which are currently ongoing or are near completion. How does the DOE plan to integrate these various mapping tasks and the resultant information?

EVALUATION OF DOE RESPONSE

- DOE indicates that integration of map data will take place during synthesis activities but provides neither text, figures, tables nor schedules demonstrating that such synthesis will take place on a continuing basis and at frequent intervals.

- As demonstration of the above point, SCP Figure 8.3.1.6-6, p. 8.3.1.6-29 (Schedule information for studies in Site Program 8.3.1.6, erosion), indicates that interface (transfer of such information) is not scheduled for the erosion program until approximately four years into the initiation of data-gathering for the four erosion studies.

- DOE indicates a willingness (intent) to integrate the mapping studies and to provide integrated products at scales appropriate in detail to fulfill the objectives of the proposed activities but does not provide details relative to how such integration is to take place, and does not identify which investigators will be linked.

- DOE's schedule for integration, if based, for example, on that identified on the above SCP Figure 8.3.1.6-6, is insufficient to assure that the various elements of the mapping program will be integrated effectively.

- The key to the integration of the mapping studies is the Geographic Information System (GIS) which should link the various DOE investigators and hopefully others (including the NRC) as well, on a continuing basis, thus permitting instant availability (access) of data at all times.

- DOE does not indicate that the GIS will link the various investigators and does not indicate when the GIS will be operational and available to these investigators.

- Closure of this question must await NRC staff evaluation of an unspecified DOE plan or plans that address the integration of the mapping tasks.

- The NRC staff considers this question open.

Section 8.3.1.4 Overview of rock characteristics program-Table 3.4.1.4-2, current representation and alternative hypotheses for models for the rock characterization program, p. 8.3.1.4-22

SCA 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 this question, 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. (The number of samples was 48 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.

- The NRC staff considers this question closed because DOE has indicated that it is aware of the issues concerning the relation between mechanical and hydraulic aperture and that relevant studies are planned in the SCP.

Section 8.3.1.4.1.1 Activity: Development of an Integrated Drilling Program, pp. 8.3.1.4-24/26

SCA 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.

- The calculations presented in support of the response to this question assume an average age of spent fuel to be 10 years out-of-reactor. However, the SCP (p. 7-21) states that the average age of the spent fuel will steadily decline and will be down to the 5-yr minimum during the last several years of operation.

- Progress toward closure of this question will require DOE to submit the proposed area calculations in Yucca Mountain Project Status Reports. The staff can then compare the area calculations 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 this question open.

Section 8.3.1.4.2.1.3 Activity: Borehole geophysical surveys, p. 8.3.1.4-57 to 8.3.1.4-58

Section 8.3.1.2.2.3.2 Activity: Site vertical borehole studies, p. 8.3.1.2-200 to 8.3.1.2-221

SCA QUESTION 4

The work of Sass and others (1988) indicates that the site is in an area of anomalously low heat flow. How will the temperature logging described in the above sections be sufficient to evaluate the significance of the preliminary conclusion?

EVALUATION OF DOE RESPONSE

- Question 4 suggested that DOE include provisions for performing temperature logging which could supplement the information obtained by Sass and others (1988)
- In the response to Question 4, DOE provided a good summation of 7 studies and activities which are being planned to evaluate the phenomena of heat flow at Yucca Mountain.
- While there are presently no planned drill holes which will be completed specifically for thermal studies, the DOE response to Question 4 identifies two activities which will be used to assess the need for future studies, including the possibility of specifically completing boreholes for thermal studies.
- While the NRC staff is still of the opinion that such information will probably be necessary to assess the tectonics, water flow characteristics and geothermal potential of Yucca Mountain, the response to Question 4 has demonstrated what appears to be a logical methodology of assessing the need for such thermal investigations, and for incorporating such data into the overall assessment of the site.
- The NRC staff considers this question closed.

Section 8.3.1.4.2.2.3 Borehole evaluation of faults and fractures, pp. 8.3.1.4-70/74

SCA 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

- It is stated in the DOE's response that DOE may evaluate the need to drill angled boreholes on the basis of data obtained from coreholes drilled early in the site characterization program.

- DOE's response to this question is based on DOE's statement 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. The staff considers that the DOE's response is insufficient because it provides no reference to support its statement. For example, DOE does not indicate the number of inclined core holes used as a basis to reach this conclusion.

- It is unlikely that vertical boreholes can be used to evaluate the need for angled boreholes as stated in the last sentence of DOE's response.

- The NRC staff considers DOE's response insufficient and therefore the question remains open. In order to make progress toward closure of this question, DOE should provide evidence supporting its statement 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.

Section 8.3.1.4.2.2.4 Activity: Geologic Mapping of the Exploratory Shaft and Drifts

SCA QUESTION 6

Explain what is meant by the statement in the last paragraph of page 8.3.1.4-75 that the discontinuities and other features of interest to be mapped "will be identified based in part, but not exclusively, on predetermined criteria." Also, what are the "criteria"?

EVALUATION OF DOE RESPONSE

- DOE indicates (see response to Comment 38 as well) that all fractures (this includes fractures that may qualify as minor faults) would be mapped in detail, as described in Study Plan 8.3.1.4.2.2 (Characterization of the Structural Features Within the Site Area.)

- DOE has responded affirmatively to the NRC's recommendation that all faults and fault zones (both minor and major) encountered in the shafts and drifts will be mapped in detail.

- Additionally, DOE states that all fractures (this includes minor faults) will be characterized as fully as possible (see response to Comment 38 as well).

- Had these concepts been expressed and commitments made in the SCP, this question would not have been raised. Adequacy of mapping criteria will be evaluated as the technical procedures are issued.

- The NRC staff considers this question closed.

Section 8.3.1.4.2.2.4 Activity: Geologic mapping of the exploratory shaft and drifts, pp. 8.3.1.4-74/79

SCA 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 to be conducted 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 NRC staff considers this question closed.

Section 8.3.1.4.3 Investigation: Development of three-dimensional model of rock characteristics at the repository site, pp. 8.3.1.4-84/86

SCA 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 also the NRC staff evaluation of DOE's response to SCA 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 to identify uncertainties inherent in a particular model. Progress toward closure of this question will depend on DOE's submittal and NRC staff review of these descriptions.

- The NRC staff considers DOE's response incomplete and therefore considers this question open.

Section 8.3.1.4.3.1.1 Activity: Systematic drilling program (Analysis and sampling strategy), p. 8.3.1.4-98

SCA 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. Neither 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.
- DOE's response does not address the specific question raised, namely how sequential testing of multiple properties on the same samples will be implemented.
- Progress toward answering the question may result from DOE's submittal and subsequent NRC staff review of the study plan process mentioned in DOE's response.
- The NRC staff considers this question open.

Section 8.3.1.4.3.2.1 Activity: Development of three-dimensional models of rock characteristics at the repository site, p. 8.3.1.4-102

SCA 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 states that different block sizes may be used for different block properties or purposes. DOE's response further states that block size may be a function of variability of a property or sensitivity to that variability.

- DOE's response states that meaningful geostatistical simulations can be conducted using block sizes that are much smaller than the spacing of observed data. .

- Based on DOE's information about the modeling activities under this study that will be conducted to help solve specific design and performance problems, the NRC staff considers this question closed.

Section 8.3.1.4.4 Schedule for the rock characteristics program, p.8.3.1.4-105

SCA 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 closed.

Section 8.3.1.8.1.1.1 Activity: Location and timing of volcanic events

SCA QUESTION 12

Why has the Lunar Crater area not been included as a possible natural analog for detailed study of the processes related to basaltic volcanism in the Death Valley-Pancake Range volcanic belt?

EVALUATION OF DOE RESPONSE

- The response to this question indicates that Lunar Crater will be studied as part of the volcanism investigation for the Site Characterization Plan. The response indicates that activities in Study Plan 8.3.1.8.5.1 (i.e., Characterization of volcanic features) describe the studies of the Lunar Crater area.

- However, the criteria used in Study Plan 8.3.1.8.5.1 for the selection of volcanic fields for study suggest, however, that Lunar Crater will not necessarily be investigated. Specifically, the selection criteria state that:

  1) Preference will be given to volcanic fields of closest proximity to the Yucca Mountain region. Lunar Crater is greater than 100 km from Yucca Mountain;

  2) Emphasis will be placed on selecting volcanic fields most analogous to Crater Flat volcanic field (small volume, alkali basalt). Lunar Crater has over 100 Quaternary volcanic centers and may not be classified as a field of small volume; and

  3) Emphasis will be placed on choosing volcanic fields that exhibit evidence of being extinct. Lunar Crater is considered to be the youngest and most active field in the Death Valley-Pancake Range belt, and data suggest that the field is still active (Crowe and others, 1986).

- The response to this question indicates that the "70 km limit noted for Activity 8.3.1.8.1.1.1, Location and timing of volcanic events, applied to maps that will be compiled on the location, volume, and chronology of volcanic centers in the Yucca Mountain region" and that Study Plan 8.3.1.8.1.1 would eliminate any possible confusion that the Lunar Crater Volcanic Field would not be studied. However, the basis point referred, not to the citation in 8.3.1.8.1.1.1 as indicated in the response, but to the listing of parameters for Investigation 8.3.1.8.5 (p. 8.3.1.8-105), Studies to provide the information required by the analysis and assessment investigations of the tectonics program, which contains the 70 km limitation.

- The NRC staff considers that active volcanic fields (e.g., Lunar Crater) in the Basin and Range Province which may not meet the criteria specified in Study Plan 8.3.1.8.5.1 should also be given emphasis for investigation.

- Closure of this question must await evidence that the 70 km criteria specified in the parameters for Investigation 8.3.1.8.5 is not an arbitrary limit on investigations of volcanic processes.

- The NRC staff considers this question open.

REFERENCE

Crowe, B.M., Wohletz, K.H., Vaniman, D.T., Gladney, E., and Bower, N., 1986, Status of volcanic hazard studies for the Nevada Nuclear Waste Storage Investigations: Los Alamos National Laboratory, LA-9325-MS, V. II, 101 p.

Section 8.3.1.8.5.1.5 Activity: Geochemical cycles of basaltic volcanic fields

SCA QUESTION 13

What is the basis for statements made about the migration, structural boundaries and stage of volcanism at Yucca Mountain. These statements appear to be unsupported by data presented in the SCP. Data in the SCP references and conclusions made in the SCP appear contradictory.

EVALUATION OF DOE RESPONSE

- The response to this question indicates that the concerns expressed have been addressed by completely revising Activity 8.3.1.8.5.1.5 in the study plan on Characterization of Volcanic Features (8.3.1.8.5.1).
- The staff has evaluated Activity 8.3.1.8.5.1.5 and considers that the revisions made have addressed the concerns raised by Question 13.
- The NRC staff considers this question closed.

Section 8.3.1.9 Human Intrusion

Section 1.6.1 Drilling and Excavation History

SCA QUESTION 14

The SCP does not appear to consider historical records of claims and/or leases in its evaluation of previous drilling or excavation at Yucca Mountain. What consideration has been given to historical maps and claim and lease information in establishing the position that "no further investigation of previous drilling or mining is needed" (p. 1-213) in the proposed repository area?

EVALUATION OF DOE RESPONSE

- DOE indicates that the natural resources assessment program, Study Plan 8.3.1.9.2.1 (Natural resource assessment of Yucca Mountain, Nye County, Nevada), now in preliminary draft stage, will respond to this question by addressing pertinent historical information, including prospects and currently or previously active mines.

- Based upon DOE's logic diagram for Study Plan 8.3.1.9.2.1 (SCP Figure 8.3.1.9-3, p. 8.3.1.9-22), and upon DOE's indications (Activity 8.3.1.8.5.2.3, SCP p. 8.3.1.9-35) that even more activities are required to support the natural resources assessment of Yucca Mountain study plan than those indicated on the logic diagram, it is clear that the response to this question will be dependent upon DOE's completion of not only the above study plan, but numerous supportive studies, investigations, and technical procedures.

- The response did not provide any new information specifically addressing the bases of this question.

- Closure of this question must await NRC staff evaluation of Study Plan 8.3.1.9.2.1 and other relevant study plans.

- The NRC staff considers this question open.

Section 8.3.1.9.2.1 Study: Natural resource assessment of Yucca Mountain, Nye County, Nevada

SCA QUESTION 15

What is the basis for SCP statements with respect to resource exploration and mineral resource potential? The following statements are inconsistent and/or fail to consider or integrate alternative information.

EVALUATION OF DOE RESPONSE

- DOE indicates that Study Plan 8.3.1.9.2.1 (Natural resource assessment of Yucca Mountain, Nye County, Nevada), now in preliminary draft stage, will respond to this question by addressing (1) appropriate modeling wherein both discovered and undiscovered mineral resources, including those that may not be presently economic, will be considered and (2) by not restricting DOE's mineral resource evaluations to within one kilometer of the earth's surface.

- Based upon DOE's logic diagram for Study Plan 8.3.1.9.2.1 (SCP Figure 8.3.1.9-3, p. 8.3.1.9-22), and upon DOE's indications (Activity 8.3.1.8.5.2.3, SCP p. 8.3.1.9-35) that even more activities are required to support the natural resources assessment of Yucca Mountain study plan than those indicated on the logic diagram, it is clear that the response to this question will be dependent upon DOE's completion of not only the above study plan, but numerous supportive activities, investigations, and technical procedures.

- The response provided no new information addressing the first basis point for this question, which questioned the SCP conclusion that "on the basis of currently available data and regional comparisons, the mineral resource potential of the site is considered low."

- Closure of this question must await NRC staff evaluation of Study Plan 8.3.1.9.2.1 and other relevant study plans.

- The NRC staff considers this question open.

Section 8.3.1.13.2.4 Activity: Evaluate the impact of ground motion from nuclear testing activities at the NTS, p. 8.3.1.13-11

SCA 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

- o 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.

- o DOE indicates that stresses predicted at Yucca Mountain for the design basis UNE were small.

- o The NRC staff considers this question closed.

Section 8.3.1.15 Performance and design parameters, tentative goals, and characterization parameters for thermal and mechanical properties program, Table 8.3.1.5-1, pp. 8.3.1.15-2/13

SCA 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 DOE's submittal and subsequent NRC review of the referenced study plan.
- The NRC staff considers this question open.

Section 8.3.1.15.1 Investigation: Studies to provide the required information for spatial distribution of thermal and mechanical properties, pp. 8.3.1.15-23/31

SCA 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 explains the relevance of rock mass response in evaluating opening performance. The NRC staff agrees that joint movement is an important aspect and should be considered as a potential criterion in evaluating rock mass response.

- The NRC staff considers this question closed.

Section 8.3.1.17 Preclosure Tectonics

SCA QUESTION 19

What consideration is being given to the use of side looking airborne radar (SLAR) at Yucca Mountain?

EVALUATION OF DOE RESPONSE

- o DOE states that acquisition of the SLAR data set (in the form of corrected synthetic-aperture radar [SAR] mosaics) is included within its geophysical remote sensing effort and that the Yucca Mountain region will be covered by four two-degree quadrangles at a scale of 1:250,000. The quadrangles identified are: Las Vegas, Caliente, Goldfield and Death Valley.

- o DOE describes the status of the four SAR mosaics as follows:

  a. The mosaic for the Las Vegas quadrangle is available.
  b. A mosaic for the Caliente quadrangle can be prepared.
  c. Mosaics are not yet available for the two remaining quadrangles (Goldfield and Death Valley.)

- o DOE indicates that Activity 8.3.1.17.4.3.5 of Study Plan 8.3.1.17.4.3 contains substantial plans for the geologic application of the SAR mosaics for structural interpretation of the Yucca Mountain region.

- o The NRC staff considers this question closed.

REFERENCE

Oliver, H.W., E.L. Hardin, and P.H. Nelson, 1990, "White Paper," Status of data, major results and plans for geophysical activities, Yucca Mountain Project. Yucca Mountain Project. YMP/90-38, U.S. Department of Energy, Las Vegas, Nevada, 1990.

Section 8.3.2.2.3 Information Need 1.11.13, Design concepts for orientation, geometry, layout and depth of the underground facility that contribute to waste isolation, including flexibility to accommodate site-specific conditions, pp. 8.3.2.2-48/50

Section 8.3.2.5.6 Information Need 4.4.6, Development and demonstraion of required equipment

SCA 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 SCP 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's response does not sufficiently describe the contents of the unpublished report SAND88-3073. Progress toward closure may result from DOE's submittal and staff review of SAND88-3073 and relevant future SCP Progress Reports.

- The NRC staff considers this question open.

REFERENCE

Unpublished Report (Authors and Title not known), SAND88-3073, Sandia National Laboratories, Albuquerque, NM.

Section 8.3.2.3-3 Parameters required for Issue 2.7 (Radiological Safety), p. 8.3.2.3-30

SCA 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 values (e.g., 65% saturation of host rock) are realistic?

EVALUATION OF DOE RESPONSE

- DOE's response does not sufficiently address the question, i.e., it does not identify the process used to assure 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, implies 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 states 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 first sentence of the second paragraph of the DOE's response states that, "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 suggests 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 DOE's response that "existing SCP activities for determining fracture geometry and properties ... will provide the information necessary."

- The non-responsiveness to the first two items in the Basis of SCA Question 21 raises the level of concern about the adequacy of the subject SCP sections.

- Progress toward closure of this question will require a clearer explanation of the process by which site characterization needs with respect to radiation shielding were developed.

- The NRC staff considers this question open.

Section 8.3.2.5 Issue resolution strategy for Issue 4.4: Are the technologies of repository construction, operation, closure and decommissioning adequately established for the resolution of the performance issues? pp. 8.3.2.5-7/17

SCA 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

- o DOE's response does not sufficiently address the question, i.e., it does not provide a rationale by which the tentative performance goals have been selected.
- o 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."
- o DOE's response refers to the DOE's response to SCA Comments 1 and 43 regarding "goals." DOE's response to SCA 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.
- o Progress toward closure of Question 22 can be made if DOE's future design and supporting documents provide sufficient details regarding the rationale for determination of the tentative performance goals given in the SCP Table 8.3.2.5-1 and 2.
- o The NRC staff considers this question open.

Section 8.3.2.5.7 Information Need 4.4.7, Design analyses, including those addressing impacts of surface conditions, rock characteristics, hydrology, and tectonic activity, pp. 8.3.2.5-61/83

SCA 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.

- In this response, 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. See also the NRC staff evaluation of DOE's response to SCA Comment 56.

- The NRC staff considers DOE's response incomplete and therefore considers the question open.

Section 8.3.3.1 Overview of the seal program (p. 8.3.3.1, second paragraph)

SCA 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

- o 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.
- o DOE's response explains how the concerns expressed in the Basis to SCA Question 24 about apparent contradictions with regard to rock/liner interactions are implicitly accounted for in the analyses supporting the SCP statement.
- o The NRC staff considers this question closed.

Section 8.3.3.1 Overview of the seal program, pp. 8.3.3.1-1/4

SCA 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

- o DOE's response states that evaluation of airflow properties, to varying degrees, are planned in a number of studies in the SCP. The studies referenced 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.

- o 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 airflow properties for faults will be included.

- o Progress toward closure of the question will require DOE's submittal for NRC review of the referenced study plans 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.

- o The NRC staff considers this question open.

Section 8.3.3.2 Issue resolution strategy for Issue 1.12, pp. 8.3.3.2-1/62

SCA QUESTION 26

There is an apparent 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 in-flow for the first 400 years after closure. What are the potential impacts of inconsistencies in tentative design 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 in the response for the suggested insertion of the text in the SCP is incorrect).

- The NRC staff considers this question closed.

Section 8.3.3.2-2 Issue resolution strategy for Issue 1.12, Table 8.3.3.2-2, general design constraints passed to Issue 1.11, configuration of underground facilities (post-closure) for major repository features from sealing program, p. 8.3.3.2-13

SCA QUESTION 27

Does ES-1 have 150 m^3 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) and later calculation provided by Fernandez et al. (1988) which indicated that this tentative goal would be met.

- DOE's response further indicates that the design goal should be changed from 150 m^3 to 50 m^3, since even under severe precipitation events the drainage into ES-1 ranges from 0 to 50 m^3. The value of 50 m^3 was obtained through a series of calculations performed by Fernandez et al. (1988) under several scenarios.

- Since DOE has indicated that the design goal should be changed from 150 m^3 to 50 m^3, the NRC staff considers this question closed.

REFERENCES

Fernandez, J.A., and M.D. Freshley, 1984. Repository Sealing Concepts for the Nevada Nuclear Waste Storage Investigations Project, SAND83-1778, Sandia National Laboratories, Albuquerque, NM.

Fernandex, J.A., T.E. Hinkebein, and J.B. Case, 1988. Selected Analyses to Evaluate the Effect of the Exploratory Shafts on Repository Performance at Yucca Mountain, SAND85-0598, Sandia National Laboratories, Albuquerque, NM.

Section 8.3.3.2-2 Issue resolution strategy for Issue 8.12, Table 8.3.3.2-2, p. 8.3.3.2-13

SCA 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

- o 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."

- o 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 unit (which is much weaker, and deeper, hence presumably more highly stressed, than the Topopah Spring); and
  --Seal testing.

- o 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. The NRC staff considers that DOE has not sufficiently demonstrated that if the sealing issue is not satisfactorily addressed by DOE, it would not result in significant adverse effect on licensing.

- o Inasmuch as the DOE response indicates that penetration of the Calico Hills unit is being evaluated as part of the Calico Hills Risk/Benefit Analysis, and that results of that analysis are being integrated with the Exploratory Shaft Facility Alternatives Study, a step toward resolution of this question may be NRC staff review of DOE's reports of the results of those two studies.

- o The NRC staff considers this question open.

Section 8.3.3.2.2.3 Study 1.12.2.3: In situ testing of seal components, pp.8.3.3.2-41/62

SCA 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 NRC staff considers this question closed.

Section 8.3.4 Waste Package Program (Waste package postclosure compliance strategy, p. 8.3.4-3. para.4)

SCA QUESTION 30

It is stated that the expected quality of the water is such that it will have little impact on the long-term integrity of the waste packages.

What is the expected quality of the water and how might this quality vary over the lifetime of the repository?

EVALUATION OF DOE RESPONSE

- o DOE indicates that the expected quality of the water and the variation of the quality over the lifetime of the repository will be unknown until the results of activities described in Study Plan 8.3.4.2.4.1 are completed.
- o The NRC staff considers this question open.

Section 8.3.4 Waste package program (Waste package postclosure compliance strategy, p. 8.3.4-4)

SCA QUESTION 31

It is stated that, for spent fuel, reliance (i.e., performance allocation) is placed on the cladding during the early years to limit the release of radionuclides with short half lives. How can performance allocation or reliance be placed on the cladding of those spent fuel elements which fail or "leak" during reactor operation? Will spent fuel "leakers" be identified and fixed prior to packing for emplacement in the repository?

EVALUATION OF DOE RESPONSE

- DOE's response does not provide any justification for their estimates of cladding failures.
- DOE does not indicate how spent fuel "leakers" would be identified and fixed prior to emplacement in the repository.
- The NRC staff considers this question open.

Section 8.3.4.1.2 Waste package components, p. 8.3.4.1-5 para. 3

SCA QUESTION 32

It is stated that the borosilicate glass waste form inside a stainless steel pour canister will be placed in a metal container similar to that to be used for spent fuel.

What is meant by "similar"?

EVALUATION OF DOE RESPONSE

- o DOE does not indicate their definition of "similar" in section 8.3.4.1.2.
- o DOE does not indicate what they would do if dissimilar materials were selected for the borosilicate glass waste and containers.
- o At this time, design details have not been developed by DOE to determine pour canister and spent fuel container compatibility. However, DOE should close this question before the stainless steel pour canisters are used to contain any radioactive waste glass at the West Valley Demonstration Project and the Defense Waste Processing Facility.
- o The NRC staff considers this question open.

Section 8.3.4.2.C. Emplacement hole drainage. Design goal for drainage of emplacement boreholes, p. 8.3.4.2-27 para. 3

SCA QUESTION 33

It is stated that the accumulation of standing water in boreholes would lead to deleterious effects on the waste package performance. For that reason, as part of the performance allocation process, a design goal (#2) for drainage from boreholes is to allow no more than 5L of standing water per package to accumulate in the emplacement hole for the first 1,000 yr. following repository closure.

How can the presence of standing water during the first 1,000 yr. be justified? What is the basis for 5L of standing water per canister being acceptable?

EVALUATION OF DOE RESPONSE

- DOE explains that the 5L of standing water per package was based upon a conservative estimate of the water flux through the emplacement boreholes and cited page 8.3.4.2-25 of the SCP as the reference. The NRC staff finds the information to be sufficient at this time.

- DOE indicates that all models developed for performance assessment, consider both vapor phase and aqueous corrosion, both with and without crevices. The NRC staff finds the information to be sufficient at this time.

- DOE does not provide any test plans to address the possible failure processes (e.g. water-line corrosion, crevice or galvanic corrosion between the canister and the base support and clogging of the rock mass below and around the borehole) stated in NRC's concern.

- The NRC staff considers this question open with respect to DOE's plans to address the possible failure processes stated in NRC's concern.

Section 8.3.4.2.G. Waste package fabrication and handling before emplacement. Design goal for closure, p. 8.3.4.2-30 para. 6

SCA QUESTION 34

It is stated that the level of undetected defective closures will be shown to be less than 1%.

What is meant by undetected defective closures? Does it mean undetected defects? What is the rationale for 1%? If the "defects" are "undetected" how can it possibly be shown conclusively that the number of "defective closures" is anything other than 0%? Furthermore, if the defects are "undetected," it is reasonable to assume that their characteristics/features and precise location cannot be determined with certainty, and that they cannot be repaired. Under such circumstances, what assurance is there that these defects will not get any larger or increase in number prior to emplacement or during the period requiring "substantially complete containment" of radionuclides?

EVALUATION OF DOE RESPONSE

- DOE has defined what was meant by the term "undetected defective closure."
- DOE expects to provide support for their criterion that the level of undetected defective closures be less than an upper bound of 1%, when welding tests and examinations are conducted on actual full scale containers.
- The NRC staff continues its efforts to develop guidance on the meaning of the containment requirement and how this requirement would be evaluated by NRC.
- The NRC staff considers this comment closed as to the definition of the term "undetected defective closure," but open as to DOE's criterion of the acceptable level of undetected defective closures and demonstration that these undetected closures can meet all pre-closure and post-closure requirements regarding containment and isolation of waste.

Section 8.3.4.2.G Waste package fabrication and handling before emplacement. Design goal for closure, p. 8.3.4.2-30 para. 6

SCA QUESTION 35

It is stated that the closure process will be capable of being performed and inspected under remote conditions with a reliability such that the containment would be capable of passing a standard helium leak test at the level of 1 x 10E-7 atm-cu cm/sec.

What is the basis for the helium leak test acceptance criteria?

EVALUATION OF DOE RESPONSE

- DOE cites ASME Section V, Article 10, Appendix IV, 1986 as the basis for the helium leak test acceptance criteria and indicates that the criteria will be assessed further during waste package design. However, DOE does not provide any assessment or information that demonstrates that the helium leak test acceptance criteria are consistent with the performance requirements of 10 CFR 60.113 for the engineered barrier system.

- The NRC staff considers this question closed as to the basis for the helium leak test acceptance criteria, but open as to whether the criteria are consistent with 10 CFR 60.113.

Section 8.3.4.2.G. Waste package fabrication and handling before emplacement. Design goal for handling. p. 8.3.4.2-30 para. 9

SCA QUESTION 36

It is stated that containers will not be allowed to contact corrosive chemicals during surface-handling and emplacement operations except as needed for surface finishing.

What kind of surface finishing would be anticipated or required for the HLW containers prior to emplacement? Would any corrosive chemicals be necessary or allowed for surface finishing for the containers? What chemicals would be allowed/prohibited? How long will they be in contact with the canister surface? What techniques will be used to verify that they have been completely removed prior to emplacement in the repository and that they have had no adverse impact on the containers?

EVALUATION OF DOE RESPONSE

- DOE indicates that they will defer consideration of container surface finishing, cleaning, and condition until site data, detailed designs, and material properties are available.
- The subject of container decontamination is reasonably independent of the site selection, though not of material properties and design. Therefore, program plans and work on decontamination should progress as waste package designs are developed.
- The NRC staff considers this question open.

Section 8.3.4.2.G. Waste package fabrication and handling before emplacement. Design goal for handling. p. 8.3.4.2-30 para. 9

SCA QUESTION 37

One of the design goals (#2) to avoid damage from handling that affects performance is not to emplace any container that is subjected to an impact load equivalent to a free-fall of 10-cm or more during handling.

What is the basis for the 10-cm free-fall acceptance criterion? Is this criterion based on the damage to the canister and/or its contents?

EVALUATION OF DOE RESPONSE

- DOE does not provide the basis for the 10 cm free-fall acceptance criterion, but indicates that further development of this criterion will await detailed designs.
- DOE does not describe any techniques that might be used to determine the suitability or unsuitability of a container in the event of a container drop.
- The NRC staff considers this question open.

Section 8.3.4.2.G. Waste package fabrication and handling before emplacement. Design goal for handling. p. 8.3.4.2-31 para. 1

SCA QUESTION 38

One of the design goals (#3) to avoid damage from handling that affects performance is not to emplace any container that is scratched so that the metal is thinned by 1-mm or more.

What is the basis for the 1-mm thinning criterion? How does this relate to the variation/tolerance in the nominal wall thickness of the canister material? What is the allowed variation in canister wall thickness? Is the scratch design goal of 1-mm depth independent of the canister material? Would a scratch depth of 1-mm or less create a potential location for crevice corrosion?

EVALUATION OF DOE RESPONSE

- DOE does not provide the basis for the 1 mm thinning criterion, but indicates that the criterion will be evaluated as detailed designs, material performance data, and performance scenarios are developed.
- DOE did not respond to the question about whether the scratch design goal is independent of canister material.
- DOE did not respond to the question about a scratch depth of 1-mm or less creating a potential location for crevice corrosion, nor did they describe techniques for detecting scratches and measuring wall thinning of scratch locations.
- The NRC staff considers this question open.

Section 8.3.4.2.G. Waste package fabrication and handling before emplacement. Design goal for handling. p. 8.3.4-31, para. 1

SCA QUESTION 39

One of the design goals (#4) to avoid damage from handling that affects performance is not to emplace any container that has experienced an unusual process history that would cause new corrosion considerations to arise.

What is an "unusual process history"? What kinds of new corrosion considerations can arise? Give examples over the range of anticipated or potential process histories. What are DOE's plans for disposition of this kind of waste?

EVALUATION OF DOE RESPONSE

- DOE did not define the term "unusual process history" but states that the criterion will be further developed following availability of detailed designs, material performance data, and performance scenarios.
- DOE did not respond to the question about what new corrosion considerations can arise.
- DOE did not provide any examples of the range of anticipated or potential process histories.
- DOE did not provide any plans for disposition of this kind of waste.
- The NRC staff considers this question open.

Section 8.3.4.2.H. Alteration to the environment caused by nonwaste package components. Design goals for the borehole liner. p. 8.3.4.2-31, para. 5

SCA QUESTION 40

One of the design goals (#1) for the liner is that the corrosion rate of the borehole liner by uniform corrosion will be within a factor of 2 of that for the container material.

What is the basis of the factor of 2? Is it two times greater or half the corrosion rate of the canister material? Since the borehole liner will be in contact with the geologic formation of the region, what testing plans have been developed to test the corrosion behavior of the candidate liner materials in the presence of tuff geologic formations? What will be the effects of the water containing liner corrosion products on the materials response of the HLW container?

EVALUATION OF DOE RESPONSE

- DOE explained that the choice of the factor of 2 on page 8.3.4.2-31, paragraph 5 is arbitrary. It is one of the two goals required of the liner: that the borehole liner be of the same alloy family as the container material and that the corrosion rate of the borehole liner be less than two times that of the container material. DOE indicated that the factor would be evaluated during the development of detailed designs and material performance data.

- DOE indicated that the corrosion behavior of the candidate liner materials would be addressed in the experimental program described in Section 8.3.5.9.2 of the Site Characterization Plan.

- DOE did not respond to the question about the effects of water containing liner corrosion products on the HLW canister.

- The NRC staff considers this question closed as to the testing plans for the corrosion behavior of candidate liner materials, but open for the remaining issue regarding water containing liner corrosion products.

Section 8.3.5.2 Issue resolution strategy for Issue 2.4: Can the repository be designed, constructed, operated, closed, and decommissioned so that the option of waste retrieval will be preserved as required by 10 CFR 60.112? pp. 8.3.5.2-1/3

SCA 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 states that "There are no additional site characterization information needs to support 10 CFR 60.132(a), only requirements for the facility design itself."
- Additional site characterization information, such as surface soil properties and input to foundation design, might 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 this question open.

Section 8.3.5.2.3 Information Need 2.4.3, Logic, p. 8.3.5.2-39, Point 2

SCA 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-emplacement hole stability analysis has not yet been performed and commits that the analysis referred in the NRC question will be performed during repository advanced conceptual design.
- Progress toward closure of the question may be made when DOE performs and submits for NRC staff review the analysis necessary to address this question.
- The NRC staff considers this question open.

Section 8.3.5.3.1	Information need 2.1.1: Site and design information needed to assess the preclosure radiological safety: pp. 8.3.5.3-20 to 8.3.5.3-23. Table 8.3.5.3-2. Parameters required for issue 2.1 (public radiological exposure-normal conditions)
Section 8.3.5.4.1	Information need 2.2.1: Determination of radiation environment in surface and subsurface facilities due to natural and man-made radioactively. Table 8.3.5.4-2. Parameters required for issues 2.2 (worker radiological safety-normal conditions)

SCA QUESTION 43

Are Anticipated Operational Occurrences being considered as part of normal conditions in the preclosure design and analysis?

EVALUATION OF DOE RESPONSE

- The purpose of Question 43 was to assure that DOE would consider those internal and external events which are expected to occur one or more times during the operational life of the facility - anticipated operational occurrences - as part of the normal operating conditions in the design and analysis of the repository facilities.

- The response to this question explicitly states that DOE will consider anticipated operational occurrences as part of the normal operating conditions in subsequent design phases.

- The NRC staff considers this question closed.

Section 8.3.5.5.1 Information Need 2.3.1: Determination of credible accident sequences and their respective frequencies applicable to the repository

SCA QUESTION 44

The magnitude of the dose to members of the public during accident conditions (and consequently the Q-list) is highly dependent upon the numbers of fuel assemblies (or waste canisters) assumed to be breached in those accidents. What are the bases for the assumed numbers of breached assemblies or canisters?

EVALUATION OF DOE RESPONSE

- In its response, DOE has indicated that its estimate is based on an assumed number of fuel assemblies that would be "...in residence at a given location in the waste-handling building..." that could be breached during accidents. DOE also has indicated that more refined estimates will be prepared during the Advanced Conceptual Design (ACD) Stage (starting around October 1992 and ending around June 1996). DOE's response does not address the possibility that a number of waste forms in residence at multiple locations could fail simultaneously or sequentially in a credible manner.

- The NRC staff considers this question open. Closure of this question would require that DOE consider failures of waste forms in multiple locations and provide more rigorous bases for the number of failed waste forms at any given location.

Section 8.3.5.5.1 Information Need 2.3.1: Determination of credible accident sequences and their respective frequencies applicable to the repository

SCA QUESTION 45

The SCP does not identify whether additional data are needed to establish particulate source terms for the waste package, particulate retention factors by containing vessels, or plateout or gravitational settlement factors for the preclosure phase. What investigations are planned?

EVALUATION OF DOE RESPONSE

- In its response, DOE recognized a future need for additional design data of this type, but its response did not describe any plans for the investigations necessary to obtain this data.
- DOE's response states that the data in question are design data rather than site data and that as such they are not included as part of site characterization. The NRC staff disagrees with this interpretation of site characterization.
- The NRC staff considers this question open. To close this question, DOE needs to identify its plans for investigations of these phenomena.

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objective for containment as required by 10 CFR 60.113? (Tentative goals for release from the waste packages) p. 8.3.5.9-19, Para. 3

SCA QUESTION 46

It is stated that DOE considers it appropriate to require that release of isotopes with long half-lives from the waste packages be controlled at a stricter standard during the containment period than during post-containment period.

What is the basis of this statement?

EVALUATION OF DOE RESPONSE

- DOE indicates that it has done this to live within the spirit of "substantially complete containment" as interpreted by DOE; however, it will "respond appropriately" when a clearer definition of "substantially complete containment" becomes available.
- The NRC staff has an ongoing effort to clarify the meaning of "substantially complete containment."
- The NRC staff considers this question open.

Section 8.3.5.9 Issue resolution strategy for Issue 1.4: Will the waste package meet the performance objectives for containment as required by 10 CFR 60.113? (Performance allocation) p. 8.3.5.9-23, para.2

SCA QUESTION 47

It is stated that some preclosure container breaches will escape detection and that a very small fraction of containers will breach during containment. Further, it is stated that these breaches may not constitute failure since failure is defined as a breach large enough to allow significant air flow (1 x 10E-4 atm- cu cm/s) into the container. It is also stated that this test is a general standard accepted by the nuclear industry.

What is the origin of the stated definition of a failure? What is the basis for its applicability for containers containing HLW? What segment of the nuclear industry accepts it as a general standard? For which component(s) is this standard used?

EVALUATION OF DOE RESPONSE

- DOE indicates that their definition of failure is preliminary and will be assessed pending further definition of "substantially complete containment."
- DOE did not provide any additional information related to testing and demonstrating that containers with breaches can meet the subsystem performance requirements.
- The NRC staff considers this question open.

Section 8.3.5.9.2.1.1 Subactivity 1.4.2.1.1: Establishment of selection criteria and their weighting factors

SCA QUESTION 48

The composition of the peer review panel is very important. These seven individuals should be recognized as being among the top experts in metallurgy and materials science in the United States. How are these individuals to be selected?

EVALUATION OF DOE RESPONSE

- o DOE indicates that their peer review procedures are specified in a Quality Management Procedure (QMP), 03-01, (Peer Reviews) which implements NUREG-1297. The NRC staff finds this information sufficient.
- o The NRC staff considers this question closed.

Section 8.3.5.9.2.3.2 Subactivities 1.4.2.3.2 through 1.4.2.3.9: Laboratory test plan for austenitic materials. Description p. 8.3.5.9-78 para. 1

SCA QUESTION 49

It is stated that long term, low temperature oxidation is expected to condition the surface of the container and will influence all the other subsequent degradation modes. It is also stated that these points are taken into account in the modeling activities.

What is meant by "condition the surface"? What is meant by long-term? What tests/analyses have been performed to understand the conditioning effects of low temperature oxidation? How have the surface conditioning effects been factored into the container materials selection process? How have the surface conditioning effects been taken into account in the modeling activities?

EVALUATION OF DOE RESPONSE

- DOE did not respond to the question about what is meant by "condition the surface."
- DOE did not respond to the question about what is meant by "long-term."
- DOE did not respond to the question about what tests/analyses have been performed concerning the effects of low temperature oxidation.
- DOE did not respond to the question about how surface conditioning effects have been or will be taken into account in the modeling activities.
- DOE indicates that it will defer evaluating the condition of the container surface and changes in that condition until after detailed designs, site data, material selection, fabrication process selection, and performance scenarios are available.
- The NRC staff considers this question open.

Section 8.3.5.9.3.2.7	Subactivity 1.4.3.2.7: Transgranular Stress Corrosion Cracking
Section 7.4.2.6	Pitting Corrosion, Crevice Corrosion, and Transgranular Stress Corrosion Cracking

SCA QUESTION 50

In this section and throughout the SCP is there an assumption that stress corrosion crack propagation results from anodic dissolution and removal of metal from the crack tip?

EVALUATION OF DOE RESPONSE

- DOE indicates that all degradation modes (including nonaqueous cracking and hydrogen effects) will be considered for stress corrosion cracking. The NRC staff finds this information sufficient at this time.

- The NRC staff considers this question closed.

Section 8.3.5.10 Issue resolution strategy for Issue 1.5: Will the waste package and repository engineered barrier system meet the performance objective for radionuclide release rates as required by 10 CFR 60.113?

Section 7.3.1.1.2 High-level wastes

Section 7.4.3.2 Glass waste form performance research

SCA QUESTION 51

Has DOE considered the impacts to the waste package site characterization program related to Idaho National Engineering Laboratory (INEL) and Hanford high-level wastes?

EVALUATION OF DOE RESPONSE

- DOE cites report DOE/RL-90-27 (1990) as the basis for the selection of borosilicate glass for the Hanford high-level wastes. However, DOE does not discuss how the quantity and characteristics of Hanford wastes might impact SCP planning and tests and ultimate disposition.
- DOE indicates that it will assess the impact of Idaho National Engineering Laboratory high-level wastes after additional information and selection of the waste form for those wastes has been made.
- The NRC staff considers this question open.

REFERENCES

DOE (U.S. Department of Energy), 1990. Evaluation and Selection of Borosilicate Glass as the Waste Form for Hanford High Level Radioactive Waste, DOE/RL-90-27, Richland Operations Office, Richland, WA.

Section 8.3.5.10 Issue resolution strategy for Issue 1.5: Will the waste package and repository engineered barrier systems meet the performance objective for radionuclide release rates as required by 10 CFR 60.113?

A. Waste form definition. Specification 1.3. Leaching properties. p. 8.3.5.10-34 para. 4

SCA QUESTION 52

It is stated that the leaching properties specification will require the producer to control the leaching characteristics of the glass waste form such that the release rates in a 28-day MCC-1 leach test in deionized water do not exceed certain specified limits.

Why is the specification based on release rates in deionized water when the specific water chemistry of the repository may produce different and, certainly, more representative results?

EVALUATION OF DOE RESPONSE

- DOE agrees that using a groundwater leachant would yield different results as compared to using deionized water. However, the "specific water chemistry" of the repository will not be known until well into the site characterization process.
- DOE states that the rationale for the use of deionized water in the leaching properties specification is for the waste producer to demonstrate glass quality and consistency in a 7-day Denfense Waste Processing Facility Product Consistency Test. The repository program (rather than the waste producer) has assumed the burden of conducting tests under repository-relevant conditions.
- DOE explains that the results of the 7-day Product Consistency Test will not be used directly in assessing the performance of the waste form.
- The NRC staff considers this question closed.

Section 8.3.5.10 Issue resolution strategy for Issue 1.5: Will the waste package and repository engineered barrier systems meet the performance objective for radionuclide release rates as required by 10 CFR 60.113?

Waste form definition, p. 8.3.5.10-34, para. 4

SCA QUESTION 53

Why has the cooling rate of the glass waste form not been specified?

EVALUATION OF DOE RESPONSE

- DOE agrees with the NRC that a cooling rate of the glass waste form should be specified and will take up this question with the Waste Acceptance Committee and the Materials Steering Committee.
- The NRC staff considers this question open.

Section 8.3.5.10.2.1.1 Subactivity 1.5.2.1.1: Dissolution and leaching of spent fuel

SCA QUESTION 54

Does the proposed SCP test for rate of release of radionuclides from spent fuel in J-13 water take into consideration the effect of ground water contamination by container metal ions, or the possible concentration of J-13 salts in the repository?

EVALUATION OF DOE RESPONSE

- DOE indicates that the proposed SCP test for the release rate of radionuclides from spent fuel in J-13 water will take into consideration the water chemistry and DOE acknowledges that the water chemistry depends on both the initial water composition and the changes caused by interactions with other components of the waste package and the repository system/grouts. The NRC staff finds this information sufficient at this time.

- The NRC staff considers this question closed.

Section 8.4.2 Description and location of characterization operations

Section 8.4.3 Potential impacts of site characterization activities on postclosure performance objectives

SCA QUESTION 55

Since the plans for the development of the Exploratory Shaft Facility (ESF) call for construction and use of various water handling facilities, including a water storage tank, a septic field, and a waste water lagoon, but the analysis for test interferences do not appear to analyze the potential for interference from these facilities, can the data required for site characterization be obtained without interference?

EVALUATION OF DOE RESPONSE

- The response indicates that control of water for the ESF is a "quality activity." Measures for controlling the use of water during the construction and operation of the ESF and surface-based testing facilities will be prescribed in two documents: the ESF Design Requirements and Surface-Based Testing Design Requirements.

- The response also states that recent total system performance assessment demonstrations (including one performed by NRC) indicate that details of individual facilities and/or activities cannot be meaningfully represented in total system performance assessments and that, therefore, total system performance assessments have limited use in determining the impacts of various site characterization activities and options on repository performance. The 1990 Phase 1 Demonstration of the Nuclear Regulatory Commission's Capability to Conduct a Performance Assessment for a HLW Repository was not intended to be and should not be construed as representative of a total system performance assessment or of the type of detail or conclusions that can be drawn from a complete study of this type.

- The NRC staff considers this question open pending DOE submittal and NRC staff review of the documents, ESF Design Requirements, and the Surface-Based Testing Design Requirements.

Section 8.4.2.1.2 Principal data needed for preclosure performance evaluations and design/Preclosure tectonics data needs, p. 8.4.2-15

SCA 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 displacement along faults 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 to the NRC staff.

- DOE does not describe specific plans aimed at justifying an acceptable tolerance for fault displacement.

- Progress toward closure of this question may result from DOE's submittal of the Exploratory Shaft Facility Alternatives Study if the information responding to this question is contained in the report of that Study.

- The NRC staff considers DOE's response to this question incomplete and therefore considers this question open.

Section 8.4.2.2.2.2 Drilling-related activities, (Multipurpose borehole activity), p. 8.4.2-74 Exploratory shaft facility testing operations, layout constraints, and zone of influence (Activity: Multipurpose borehole testing near the exploratory shafts), p. 8.4.2-145 Section 8.4.2.3.1

SCA QUESTION 57

How has the effect of drilling of possibly three multi-purpose 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 response states that the boreholes in the SCP were selected to be well away from excavated openings and outside any experiment influence zones. DOE's response further states that the siting constraints for the Upper Demonstration Breakout Room (UDBR) and the multi-purpose boreholes can be met without conflict.

- DOE has not substantiated its statement that the locations for three multi-purpose boreholes given in the SCP would be sufficiently far from excavated openings or experiments taking into account possible hole deviation.

- 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.

- Progress toward closure of this question can be made if DOE provides details of degree of flexibility in orienting the UDBR. A diagram of the location of the multi-purpose boreholes and underground excavations and experiments may be used for this purpose. Possible hole deviations and potential interferences should be considered.

- The NRC staff considers that DOE's response to this question is incomplete and therefore considers this question open.

Section 8.4.2.3.1 Exploratory shaft facility testing operations, layout constraints, and zones of influence, pp. 8.4.2-93/147

SCA 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 commits 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 that DOE's response is incomplete and therefore considers this question open.

Section 8.4.2.3.1 Exploratory shaft facility testing operations, layout constraints, and zones of influence, Activity: Canister-scale heater experiment, pp. 8.4.2-117/120

SCA 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 durations?

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:

  (1) 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.

  (2) The main criterion used in Bauer et al. (1988), and consequently in the SCP, is the temperature distribution and the resulting thermomechanical response, primarily the stress field. While of importance for test design, Question 59 is not based on this aspect of the experimental design; rather, the question suggests that the DOE has not demonstrated that long-term effects can be studied reliably with the planned short-term testing.

- 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 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 narrow focus of the cited criteria for test termination, primarily temperature distributions, confirms the main concern underlying Question 59, that the criteria for selecting the proposed test durations may be very narrow in scope and may not include the need for investigation of the host-rock response to prolonged exposure to likely thermal conditions.

- 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 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 is considered to be satisfactorily addressed in DOE's response.

- DOE's response does not address the fourth item in the Basis for Question 59.

- Progress toward closure of Question 59 will require that the rationale to be included in Study Plan 8.3.1.15.1.6 (In Situ Thermomechanical Properties), referenced in the response, address the items in the basis to Question 59 that remain open.

- The NRC staff considers this question open.

Section 8.4.2.3.1 Activity: Radial borehole tests, p. 8.4.2-136/137

SCA 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

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

Section 8.4.2.3.6.4 Design Flexibility pp. 8.4.2-218/219

Section 8.4.2.1.6 Conditionally planned subsurface characterization activities p. 8.4.2-32

SCA 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

- o DOE's response acknowledges that some major design changes may require significant time for design and approval and states 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.
- o No reference is provided for the architectural-engineering procedures that have been developed.
- o The NRC staff considers this question open, pending DOE's furnishing of the relevant architectural-engineering references.

Section 8.4.3.2.4 Design features that may contribute to performance, (1) separation of ESF tests from potential emplacement drifts, p. 8.4.3-34

SCA 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 ESF 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's response states that the coupling between heat and moisture transport could add a lateral component to the vertical flow model. Therefore, additional studies are planned, with the results to be reported in Yucca Mountain Project Status Reports.

- DOE's response further states that the planned minimum separations are considered sufficient to support ESF design. DOE should provide justification in the form of calculations or design analysis for its conclusion that the minimum separation distances are sufficient to support ESF design.

- Progress toward closure of this question will have to await DOE's submittal of the planned additional studies.

- The NRC staff considers this question open.

Section: Design Acceptability Analysis

SCA 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

- o DOE's response describes the independence criteria used for the Technical Assessment Review (TAR) of the ESF Title I Design and states that the criteria were met.
- o DOE's criteria for independence of TAR reviewers appear acceptable, based on comparisons to the requirements of the NRC Quality Assurance Review Plan (RP) and to NQA-1-1986, which is endorsed by the RP.
- o DOE now has a quality assurance program plan which meets the requirements of the RP, including those for independence of personnel involved in design reviews, and which has been accepted by NRC. In its response to this question, DOE commits to comply with those requirements in future ESF design activities.
- o The NRC staff considers this question closed.