



July 3, 1989

SECY-89-199

POLICY ISSUE
(Notation Vote)

For: The Commissioners

From: Hugh L. Thompson, Jr.
Deputy Executive Director for
Nuclear Material Safety, Safeguards
and Operations Support

Subject: NRC STAFF REVIEW OF THE DEPARTMENT OF ENERGY'S SITE
CHARACTERIZATION PLAN, YUCCA MOUNTAIN SITE, NEVADA RESEARCH
AND DEVELOPMENT AREA, NEVADA

Purpose: The staff intends to transmit the enclosed cover letter and concerns identified in the staff's review of the Department of Energy's (DOE) Site Characterization Plan (SCP) (i.e., Site Characterization Analysis or SCA required by 10 CFR 60.18) by July 28, 1989, in accordance with the schedule in the SCP Review Plan, unless the Commission directs otherwise.

Background: The Yucca Mountain area in southern Nevada is the candidate site selected for characterization as the nation's first geologic repository for high-level radioactive waste. The DOE is required by the Nuclear Waste Policy Act (NWPA), the Nuclear Waste Policy Amendments Act (NWPAA), and 10 CFR 60.16 to prepare an SCP to obtain the information necessary to determine the suitability of the Yucca Mountain site for a repository.

As part of its development of the SCP, on January 8, 1988 DOE issued the Consultation Draft Site Characterization Plan (CDSCP) for the Yucca Mountain, Nevada site for the information of and review by the NRC and the State of Nevada. The NRC transmitted its concerns regarding the CDSCP to the DOE on May 11, 1988. The DOE subsequently prepared the statutory SCP and issued it on December 28, 1988.

The NRC has responsibilities under NWPA and 10 CFR 60 to review the SCP and to provide its concerns to DOE in the form of an SCA. In particular, the Director of NRC's Office of Nuclear Material Safety and Safeguards is required by 10 CFR 60.18(d) to include either a statement that he has no objection to DOE's site characterization program or his specific objections with respect to DOE's program for characterization of the area concerned.

Contact:
Newton K. Stablein, NMSS
492-0446

Public
8907100064

Discussion:

The NRC staff's concerns regarding the SCP are documented in the attached SCA, including the comments and recommendations by the Director as required by 10 CFR 60.18(d). Our concerns are categorized into three levels. These levels are: (1) objection, which is a matter of such immediate seriousness to a particular area of the site characterization program that NRC would recommend DOE not start work in that area until it is satisfactorily resolved; (2) comment, which is a concern with a particular program area that would result in a significant adverse effect on licensing if not resolved, but that would not cause irreparable damage if activities in that area were started prior to resolution; and (3) question, which is a concern with the presentation of the program in the SCP that precludes understanding an important program area well enough for the NRC staff to be able to completely evaluate that area. A question identifies a concern that could result in a significant adverse effect on licensing if not resolved, but that would be unlikely to cause irreparable damage if activities in that area were started prior to resolution.

The specific objections related to DOE's site characterization program, and the major comments and recommendations on the various parts of DOE's site characterization program, are presented in SCA Section 2, Director's Comments and Recommendations. SCA Section 3 contains summaries of the NRC staff's concerns for each specific program in the SCP. SCA Section 4 contains the NRC staff's point papers, each of which sets forth a particular staff concern regarding DOE's site characterization program as well as the basis for the concern and possible actions to resolve the concern. SCA Appendix A contains the NRC staff evaluations of those NRC staff CDSCP concerns that the NRC considers to be resolved on the basis of the material presented in the SCP and its supporting references.

Based on the staff's review of the SCP, the revisions DOE has made since the CDSCP have resulted in an improved document. One indicator of the progress that has been made is the decrease in the number of objections from five, resulting from the NRC's CDSCP review, to two resulting from the SCP review. The two specific objections related to the SCP are DOE's not having a baselined quality assurance (QA) program in place that meets NRC requirements and DOE's not having demonstrated in the SCP the adequacy of the exploratory shaft facility (ESF) design and design control process. The latter objection is important because

the ESF will become part of the repository itself if the site is found to be acceptable.

In addition to the two objections, the staff has identified four particularly important comments regarding some of the programs presented in the SCP for characterizing the Yucca Mountain site. These are: (1) need for early and iterative total system performance assessments of the repository; (2) early investigations of tectonic phenomena; (3) technical integration and coordination; and (4) pressure to meet production milestones adversely affecting the site characterization program. These four comments as well as the two objections are highlighted for DOE in the transmittal letter.

Overall, the staff has identified 198 concerns (two objections, 133 comments, and 63 questions) resulting from the SCP review. As mentioned earlier, all of these concerns are presented in point papers in SCA Section 4.

In a staff requirements memorandum dated February 27, 1989, the Commission requested the staff to identify any of the SCP concerns that are directly related to regulatory uncertainties and explain the interpretation of the regulation that forms the basis for the staff's concern. The staff has identified five SCP concerns that are directly related to regulatory uncertainties. Two concerns relate to methodologies DOE plans to use to demonstrate the total repository system compliance with the EPA's standard (comments 98 and 110 in SCA Section 4), two deal with the 10 CFR 60 requirement for substantially complete containment of radionuclides within the waste package for at least 300 years (comments 5 and 80), and one relates to delineating the disturbed zone boundary (comment 92). At this time, there is not sufficient knowledge or information for the staff to resolve these uncertainties. The staff is planning to address these three regulatory uncertainty topics in three potential rulemakings, as noted in SECY-88-285, "Regulatory Strategy and Schedules for the High-Level Waste Repository Program."

During the review of the SCP the NRC staff had several interactions with the Advisory Committee on Nuclear Waste (ACNW) and its consultants to solicit its views on the SCP and the concerns identified by the NRC staff. We understand that the ACNW will be transmitting a letter to the Commission on its review of the staff's SCA.

Coordination: The Office of the General Counsel has reviewed this paper and has no legal objection.

Recommendation: That the Commission provide any changes to the enclosed SCA and transmittal letter by July 25, 1989.

- Notes
1. On July 6 and 7, 1989, NRC and DOE are meeting in Las Vegas to discuss potential approaches to resolution of the concern with the ESF design and design control process. If agreement is reached on the approach to resolve that concern at that meeting, the transmittal letter will be modified accordingly.
 2. The staff intends to transmit the cover letter and enclosed SCA to DOE by July 28, 1989 unless the Commission directs otherwise.
 3. Mr. Stello, Executive Director for Operations, has not participated in this matter.


Hugh L. Thompson, Jr.
Deputy Executive Director for
Nuclear Material Safety, Safeguards,
and Operations Support

Enclosures:

1. Letter transmitting SCA to DOE
2. Site Characterization Analysis (SCA)
(with SCP Point Papers and Appendix A - Commissioners, SECY, OGC only)

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Commissioners' comments or consent should be provided directly to the Office of the Secretary by c.o.b. Thursday, July 20, 1989.

Commission Staff Office comments, if any, should be submitted to the Commissioners NLT Thursday, July 13, 1989, with an information copy to the Office of the Secretary. If the paper is of such a nature that it requires additional time for analytical review and comment, the Commissioners and the Secretariat should be apprised of when comments may be expected.

**Proposed Letter Transmitting
Site Characterization Analysis
to DOE**

Enclosure 1



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

Mr. Sam Rousso, Acting Director
Office of Civilian Radioactive Waste Management
U. S. Department of Energy
Washington, D. C. 20545

Dear Mr. Rousso:

The Nuclear Regulatory Commission's (NRC) regulations in 10 CFR 60.16 require that the Department of Energy (DOE) submit a Site Characterization Plan (SCP) before proceeding to sink shafts at a site and to defer sinking of such shafts until such time as there has been an opportunity for Commission comments to have been solicited and considered by DOE. On December 28, 1988, DOE submitted the SCP for the Yucca Mountain Nevada site, supplementing that submittal with the Exploratory Shaft Facility (ESF) Design Acceptability Analysis (DAA) on February 9, 1989.

The NRC staff has reviewed the SCP and DAA; our concerns are identified in this letter and in the staff's analysis of the SCP, which is called the Site Characterization Analysis (SCA). Our concerns are categorized into three levels. These levels are: (1) objection, which is a matter of such immediate seriousness to a particular area of the site characterization program that NRC would recommend DOE not start work in that area until it is satisfactorily resolved; (2) comment, which is a concern with a particular program area that would result in a significant adverse effect on licensing if not resolved, but that would not cause irreparable damage if activities in that area were started prior to resolution; and (3) question, which is a concern with the presentation of the program in the SCP that precludes understanding an important program area well enough for the NRC staff to be able to completely evaluate that area. A question identifies a concern that could result in a significant adverse effect on licensing if not resolved, but that would be unlikely to cause irreparable damage if activities in that area were started prior to resolution. The NRC considers all of these concerns to be important and encourages DOE to give full attention to each of them, with a view to resolving the individual concerns as early as practicable during site characterization. In accordance with 10 CFR 60.18(g), DOE is requested to include discussions of modifications made in the site characterization program to address NRC's SCA concerns in its semiannual site characterization progress reports.

Overall the SCP is an improved document. Of the 167 concerns raised by the NRC staff regarding the Consultation Draft Site Characterization Plan (CDSCP), 105 were satisfactorily resolved on the basis of the information in the SCP. Of the remaining 62, many were partially resolved. Nevertheless, staff still has two concerns in the first category. One involves the need for a baselined quality assurance (QA) program before beginning site characterization, and the other involves the need for improvements in both the exploratory shaft facility (ESF) design and design control process.

The NRC staff previously raised a concern regarding the CDSCP because a baselined QA program that meets NRC requirements was not in place. That is still the case at the present time and thus the concern remains. However, as you are aware, NRC and DOE have agreed on a step-by-step approach for resolution of this concern. Several of the agreed upon steps necessary to resolve this concern have already taken place. Once the agreed upon steps have been satisfactorily accomplished, for each of the participants involved in a given area, the NRC has no QA related concern with DOE proceeding with that area of its site characterization program while it continues to complete the steps needed for other areas of the site characterization program.

The ESF concern arises because the SCP and the ESF Design Acceptability Analysis (DAA) do not demonstrate the adequacy of the design control process under which the ESF design presented in the SCP (Title I design) was developed or the adequacy of the design itself. This concern is based on the fact that the ESF will become part of the repository itself if the site is found to be acceptable. To resolve this concern, DOE needs to demonstrate the adequacy of both the design control process and the design which will ultimately be used for the ESF. An important part of that strategy needs to be timely interactions with the NRC staff as the yet to be completed design control process and design are developed. We stand ready to work out a mutually acceptable process whereby the NRC staff can gain an early understanding of the adequacy of the ESF design control process and of the ESF design, so that this concern can be resolved in parallel with completion of the final ESF design.

With regard to the second level of concerns, NRC has a number of comments on various site characterization program areas. NRC staff offers specific recommendations for approaches to resolve each comment in the spirit of improvements which should be made early in the ongoing site characterization program. These improvements should further our mutual goal for a site characterization program which will result in sufficient information for early identification and resolution of issues and, if the site is found to be acceptable, a complete and high quality license application. Particularly important comments requiring DOE management attention are highlighted below.

- (1) Total system performance assessments to determine compliance with 10 CFR 60.112 are not planned to be conducted periodically, starting at an early date. NRC staff considers total performance assessments should be used as a primary basis for demonstrating the ability to meet regulatory criteria and to integrate data gathering activities during site characterization. In particular, total system performance assessments need to be used together with subsystem (10 CFR 60.113) performance assessments to provide an early and ongoing evaluation of whether any of the potentially adverse conditions (10 CFR 60.122) significantly affect the ability of the site to meet the 10 CFR 60 performance objectives and whether data being gathered is adequate to make this determination.

- (2) Investigations associated with tectonic phenomena should receive early attention. At the Yucca Mountain site, an understanding of tectonic phenomena such as volcanism, faulting, and seismicity is critical to evaluating the site suitability in terms of potentially adverse conditions that could significantly affect its long term waste isolation capability. The NRC staff considers that a full range of tectonic models reasonably supported by the existing data base should be considered in planning the tectonics investigations, and that high priority should be given to conducting those investigations which can lead to a determination of whether the site has unacceptably adverse conditions based upon assessments of the potential for such phenomena as volcanism, faulting, and seismicity. Such investigations need to be conducted early in site characterization.

This recommendation is not intended nor should it be interpreted to mean that there should be a delay in any other surface-based testing or in ESF construction; rather, the full spectrum of site characterization activities should proceed, with proper coordination and integration. In conducting such tests, DOE should be striving to resolve issues that may have an impact on site performance as soon as practicable.

- (3) The need for improved program technical integration is emphasized by both the performance assessment and tectonics concerns. Although many of the individual segments of the program are of high quality, it is unclear how they are being incorporated into a coordinated and integrated program. For example, there appear to be some situations related to tectonics investigations where geophysical and geological activities intended to gather data required as input to assessments of potentially adverse conditions, e.g., faulting, may not be carried out until well after those assessments have been initiated. Other situations exist where it appears DOE plans to conduct intrusive activities, e.g., drilling and trenching, prior to, or without, conducting nonintrusive geophysical and geological activities that could provide information needed to optimize the locations of proposed drillholes and trenches. Likewise, it is not clear that data obtained from holes drilled for one investigation will be utilized as possible input into other investigations or, more importantly, that the number of boreholes has been minimized (hence minimizing potential damage to the site) by integrated planning to select borehole locations that could be used to obtain data for diverse investigations. Furthermore, the concern mentioned earlier regarding the need for total system performance assessments early in the site characterization program to integrate data gathering activities and guide evaluations of potentially adverse conditions also reflects a need for stronger coordination and integration.

Based on the specific concerns identified in the SCA, a fourth particularly important comment is the programmatic concern that the pressure to meet unrealistic schedule milestones may leave DOE insufficient time to plan proper technical information-gathering activities necessary to develop a sufficient understanding of the site, and to develop a complete and high-quality license application. The NRC pointed out this danger in its September 16, 1988 letter

to DOE on the Draft 1988 Mission Plan Amendment in which it noted that the schedule for near term program activities, including in situ site characterization, was being compressed. Specifically, despite a delay in the start of both exploratory shaft construction and in situ testing, all the subsequent program milestones were unchanged. In the SCP, DOE has not demonstrated that its current schedules allow time for conducting the site characterization activities needed to support the license application. A recent development that illustrates this concern is DOE's decision to proceed with the ESF Title II design even though the baselined quality assurance (QA) program under which that design is to be developed has not been accepted by DOE. This appears to be driven by the attempt to meet milestones for construction of the ESF.

In closing, in order to ensure that DOE fully understands our concerns and to reach a mutually agreeable approach for resolving them, we stand ready to meet with you and your staff as necessary.

Sincerely,

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

Enclosure:
Site Characterization Analysis

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

SITE CHARACTERIZATION ANALYSIS

This document is in the final stages of development. It is complete with respect to the technical substance, but some editing remains to be done.

1.0 INTRODUCTION

Background

The Yucca Mountain area in southern Nevada is the candidate site selected for characterization as the nation's first geologic repository for high-level radioactive waste. The Department of Energy (DOE) is required by the Nuclear Waste Policy Act (NWPA), the Nuclear Waste Policy Amendments Act (NWPAA), and 10 CFR Part 60 (hereafter Part 60) to prepare a site characterization plan (SCP) to obtain the information necessary to determine the suitability of the Yucca Mountain site for a repository. The NWPA and 10 CFR 60.17 delineate what information must be contained in the SCP. At the NRC-DOE SCP Level of Detail Meeting in May 1986, NRC and DOE agreed on the level of detail to be furnished by DOE in the SCP to meet the requirements of NWPA and 10 CFR 60.17.

As part of its development of the SCP, on January 8, 1988 DOE issued the Consultation Draft Site Characterization Plan (CDSCP) for the Yucca Mountain, Nevada Site for the information of and review by the NRC and the State of Nevada. The NRC transmitted its concerns regarding the CDSCP to the DOE on May 11, 1988. The DOE subsequently prepared the statutory SCP and issued it on December 28, 1988. The NRC is responsible under NWPA and 10 CFR 60.18 to review the SCP and to provide comments to DOE in the form of a Site Characterization Analysis (SCA), i.e., this document. This SCA fulfills the NRC's responsibilities with respect to DOE's SCP and serves to continue the process that has been ongoing since the passage of the NWPA of pre-license application review and consultation for early identification and resolution of potential licensing issues.

10 CFR 60.16 specifies that the SCP be submitted to the Director of NRC's Office of Nuclear Material Safety and Safeguards (hereafter the Director) before shafts are sunk at any proposed high-level radioactive waste repository site and that DOE defer shaft sinking until it has solicited and considered Commission comments. In order for NRC to have sufficient information to evaluate in preparing comments on the exploratory shaft facility (ESF) aspect of the SCP, applicable study plans relating to ESF construction-phase testing were to be provided with the SCP. DOE also agreed to furnish NRC with an ESF Design Acceptability Analysis (DAA) along with the SCP. This DAA was DOE's approach to address NRC concerns with the adequacy of the ESF Title I design and design control process resulting from NRC's concerns related to the CDSCP.

NRC Staff Review

The NRC staff has completed its review of the SCP in accordance with the NRC Division of High-Level Waste Management's "Review Plan for NRC Staff Review of DOE's Site Characterization Plan" (SCPRP), issued in December 1988. This review consisted of an acceptance review and a technical review.

Upon receipt of the SCP on December 28, 1988 the NRC staff began an acceptance review. Because the DAA and the ESF-related study plans were not submitted

with the SCP, and were not received by NRC until February 9, 1989, the NRC staff did not complete its acceptance review until March 1, 1989. On that date the NRC notified DOE that the material submitted was acceptable for technical review. However, DOE was informed that review of the ESF-related study plans could not proceed because the supporting material for those study plans was incomplete. As of May, 1989, this material had still not been received. Hence, concerns related to the study plans are not included in the SCA.

The NRC staff technical review of the SCP focused on the identification of issues, linkages among issues, the strategy for resolving issues, the information needs identified by those strategies to resolve issues, and the investigations designed to provide the needed information. Details of how the investigations are to be implemented in site characterization activities are reserved for study plans which, with the exception of the five ESF-related study plans discussed earlier, were not the focus of the NRC SCP technical review. The NRC staff also focused on DOE's consideration of and response to the NRC's CDSCP concerns to identify those that are resolved. Those CDSCP concerns that are unresolved have been incorporated into the SCP concerns.

The NRC staff became familiar at a broad level with the entire SCP but confined its technical review to those SCP sections and references within its purview, i.e., those that are related to Part 60. An example of material in the SCP that falls outside the scope of the NRC technical review is the information related to 10 CFR Part 960 (DOE's Siting Guidelines), except where that information also relates to Part 60.

The NRC staff technical review of the SCP encompassed both Part A (Chapters 1 through 7), which provides currently available information about the site and the conceptual designs of the repository and the waste package, and Part B, which presents the DOE's rationale and plans for the site characterization program. Inasmuch as the information in Chapters 1 through 7 establishes the basis for the plans laid out in Chapter 8, staff review of Chapters 1 through 7 focused on identification of concerns that bear upon the staff's assessment of the plans in Chapter 8.

Results of NRC Staff Technical Review

The NRC staff's concerns regarding the SCP are documented in this SCA, including the comments and recommendations by the Director as required by 10 CFR 60.18(d). The specific objections related to DOE's site characterization program, and the major comments and recommendations on the various parts of DOE's site characterization program as laid out in Chapter 8 of the SCP, are presented in SCA Sections 2.0-2.10, Director's Comments and Recommendations.

SCA Sections 3.0-3.8 contain summaries of the NRC staff's concerns for each specific program in Chapter 8 of the SCP. These summaries are designed to enable the reader to reach a basic understanding of the NRC staff's evaluation of each program by highlighting the most significant concerns here, while leaving the detailed discussion of the concerns and their bases to Sections

4.0-4.3 of the SCA. Two summary tables follow Section 3.9. Table 1 provides a summary of the numbers and levels of concern (objection, comment, and question) for each program, and Table 2 provides a summary of the resolution status of the NRC's CDSCP concerns, including a reference to where individual unresolved CDSCP concerns are incorporated in the SCP concerns presented in SCA Section 4.

SCA Sections 4.0-4.3 contain the NRC staff's point papers, each of which sets forth a particular staff concern regarding DOE's site characterization program. The point papers are grouped by level of concern. The papers within each level are arranged in an order determined by the number of the section in chapter 8 of the SCP to which the paper pertains. The chapter 8 section number and name are provided as part of the heading for each concern. The comments and questions related to the DAA follow the comments and questions respectively related to chapter 8 of the SCP. Concerns identified during the review of chapters 1 through 7 are factored into the point papers dealing with the corresponding plan in chapter 8.

The three levels of concern encompassed by the SCP point papers are defined as follows (and are more fully defined in the NRC staff's SCPRP): (1) objection, which is a matter of such immediate seriousness to a particular portion of the site characterization program that NRC would recommend DOE not start work in that area until it is satisfactorily resolved (e.g., potential adverse effects on repository performance; potentially significant and irreversible/unmitigable effects on characterization that would physically preclude obtaining information necessary for licensing; or fundamental inadequacies in quality assurance (QA) programs); (2) comment, which is a concern with a particular part of the program that would result in a significant adverse effect on licensing if not resolved (and hence needing early attention), but which would not cause irreparable damage if that part of site characterization were started prior to resolution; and (3) question, which is a concern with the presentation of the program in the SCP, such as missing information that should be in the SCP, an inconsistency, or an ambiguity, which precludes understanding an important part of the program well enough for the NRC staff to be able to completely evaluate that part. A question identifies a concern that could result in a significant adverse effect on licensing if not resolved, but that would be unlikely to cause irreparable damage if activities in that area were started prior to resolution. Each objection, comment, and question contains a statement of the concern, a basis for the concern, and a recommendation for a suggested resolution.

SCA Appendix A contains the NRC staff evaluations, again in the form of point papers, of those NRC staff CDSCP concerns that the NRC considers resolved on the basis of the material presented in the SCP and its supporting references. Each evaluation includes the identity of the CDSCP concern, the verbatim statement of the original concern and of the basis for the concern as these appeared in the CDSCP point paper, and an evaluation of the information in the SCP that addresses that CDSCP concern.

2.0 DIRECTOR'S COMMENTS AND RECOMMENDATIONS

The material in the CDSCP has been substantially revised and, in some areas, considerably expanded during the development of the SCP. These changes have resulted in an improved document. One indicator of the progress that has been made is the decrease in the number of objections from five, resulting from the NRC's CDSCP review, to two. One objection involves the need for a baselined quality assurance (QA) program before beginning site characterization, and the other involves the need for improvements in both the ESF design and design control process. The objections are discussed in sections 2.7 and 2.8 below.

In addition, there are a number of major comments and recommendations on the programs and key subject areas in the SCP. Comments and recommendations are presented on each particular program and subject area in the sections below (Sections 2.1-2.8). The first area discussed is the Issue Resolution Process, which is DOE's fundamental approach to identifying the regulatory issues that need to be addressed during site characterization and determining what site characterization activities are needed to obtain the information needed to resolve those issues by the time of license application submittal. The next areas discussed are the Site Program, Repository Program, Seals Program, and Waste Package Program, all of which are programs to obtain the information needed according to the Issue Resolution Process. Then the Performance Assessment Program, which uses the data obtained during site characterization to help resolve the regulatory issues identified by the Issue Resolution Process and in particular to quantitatively evaluate whether the site meets the numerical criteria of Part 60 performance objectives, is discussed. Exploratory shaft impacts on the waste isolation capability of the site and on site characterization activities are discussed next, followed by discussion of the QA program, on which DOE will have to rely at the time of licensing to demonstrate the quality of the information used in support of the license application.

Section 2 also addresses the proposed use of radioactive materials in the site characterization program (Section 2.9) and DOE's consideration of the NRC staff's CDSCP concerns in the SCP (Section 2.10).

2.1 Issue Resolution Process

The SCP commits to a systematic approach to site characterization called the Issue Resolution Strategy. This approach identifies the regulatory requirements for siting and licensing a geologic repository and describes the work that needs to be completed in site characterization to resolve the issues that are developed from the regulatory requirements. While this approach is appropriate, there are significant problems with the execution of the approach as explained in the SCP. Timely corrective action is needed to avoid problems likely to have an impact on the ability of the DOE to provide, at the end of site characterization, sufficient information for a complete and high-quality license application.

One problem area involves the consideration of alternative conceptual models. The limited consideration of alternative conceptual models in the CDSCP, with the attendant potential that testing later recognized as being needed could be precluded by earlier testing, caused the NRC staff to raise an objection (CDSCP Objection 1). The SCP contains a considerably improved discussion of alternative conceptual models, in particular in tables that present alternate hypotheses, significance of the alternatives, and activities or studies designed to discriminate among them or to reduce uncertainty in the current understanding of the site. The range of alternative conceptual models is now wide enough that, even though some potentially important models may not have been included in the hypothesis testing tables, it no longer appears that essential investigations are likely to be precluded. However, the contents of the hypothesis testing tables still raise a number of concerns that, taken together, suggest that the logic used to create the tables needs to be re-examined by DOE. For example, in addition to the aforementioned concern that some potentially important alternative conceptual models appear not to be included in the tables, it is unclear in several instances how the proposed studies will provide the data needed to differentiate among alternative conceptual models. Further, there are apparent potentially significant internal inconsistencies in several tables. Finally, there is no evidence in the hypothesis testing tables or elsewhere in the SCP that systematic consideration of alternative conceptual models was integrated across the various technical disciplines.

Another problem area involves the apparent existence of logic gaps in the execution of performance allocation, which is the process that provides the rationale for the establishment of particular site characterization activities that will lead to obtaining the information necessary to resolve the issues identified in the first stage of the Issue Resolution Strategy. Inconsistencies among the selected scenario classes and the designated performance measures and inadequacies in the selected goals are gaps that suggest the information gathered on the basis of the performance allocation may not assure that Issue 1.1, Total System Performance, will be resolved. Also, performance allocation for Waste Package Lifetime (Issue 1.4) contains performance measures related to controlled release during the containment period. These performance measures are not appropriate because they should be based on substantially complete containment during that period rather than on controlled release.

2.2 Site Program

Because the Site Program encompasses several distinct and, in most cases, major programs, comments are addressed to the individual programs rather than to the overall Site Program.

2.2.1 Geohydrology Program

There are two general technical concerns regarding the geohydrology site characterization program. The first concern is with respect to the

completeness of the descriptions of the regional and site geohydrologic systems and related modeling assumptions. The descriptions do not identify all of the important features, events, and processes that need to be considered in the development of the geohydrology testing program. In addition, the simplifying assumptions that have been made about features, events, and processes are not clearly distinguished from the features, events, and processes themselves. Since a complete presentation of these modeling assumptions has not been made for the geohydrology program, the sensitivity analyses planned to provide justification for initial modeling strategies may miss justifying some assumptions because they have not been specifically identified. Furthermore, the lack of recognition of the modeling assumptions concerning features, events, and processes may result in DOE having more confidence in its initial identification of those entities than is warranted and hence to limit the sensitivity analyses that will be used to help make adjustments to the geohydrology testing program.

The second general concern is that some of the planned field studies and activities may not be sufficient to test hypotheses about individual features, events, and processes of the site geohydrologic system. In the case of the Calico Hills unit (a nonwelded tuff below the repository horizon that has been identified as an important barrier for purposes of demonstrating compliance of the site with the performance objectives of 10 CFR Part 60), plans to characterize its geohydrologic properties are incomplete. Surface-based testing may not provide essential data about distributions and flow characteristics of fractures and faults in the Calico Hills unit, but plans for in situ testing of the Calico Hills unit are being held in abeyance because penetration of the unit within the repository block may compromise the waste isolation capabilities of the site. Another area of insufficiency in the geohydrology testing program is the set of activities planned for the study of the saturated zone. Data from single-well tests and only one multiple-well complex may not be representative of large-scale geohydrologic conditions across the site at scales of importance to repository performance.

2.2.2 Geochemistry Program

There are three general technical concerns with the geochemistry program. First, the geochemistry program may not consider all the potentially important conditions and processes that may exist at Yucca Mountain. For example, the DOE proposes modeling chemical interactions in unsaturated rock in the same way as they are modeled in saturated rock. This approach would not consider the effect of the gas phase on chemical interactions. Other examples of processes that are not considered in the SCP are (1) the effects of three separate processes--radioactive decay heat, nuclear radiation, and introduced microorganisms--on biological sorption, and (2) the effects of colloid formation resulting from site characterization and construction activities on sorption and radionuclide transport.

Another general concern is with the adequacy of some methodologies for determining the parameter values used to characterize the site. For example,

solubility techniques may not be able to completely define the thermodynamic properties of zeolites due to the metastability of the zeolite phases.

Yet another general concern is that the laboratory results obtained in the geochemistry program may not be applicable to the site environment. One aspect of the concern is that laboratory experiments are not planned to determine some parameters under certain natural conditions, e.g., fracture-flow conditions. This is the case even though it is recognized in the SCP that minerals occurring in fractures can be significantly different from those occurring in the adjacent rock matrix. A second aspect of the concern is that the use of certain parameters, e.g., distribution coefficients (K_d 's), that will be derived from laboratory geochemistry investigations to determine retardation may be invalid for certain expected conditions at Yucca Mountain.

2.2.3 Rock Characteristics Program

There are two general concerns with respect to the rock characteristics program in the SCP. First, the data being collected during site characterization are unlikely to be sufficient to develop a supportable three-dimensional rock-characteristics model for the repository area or to investigate potentially adverse conditions there. The program of drifting in the northern part of the repository block in the proposed ESF, combined with the surface-based test program, may not yield data representative of conditions and processes throughout the repository block because, based on existing information, geologic conditions in the area of the proposed ESF may not be characteristic of potentially adverse conditions elsewhere in that block.

The second general concern is that the geophysics, drilling, and mapping activities associated with the rock characteristics program does not appear to be sufficiently well integrated with activities related to other site programs, such as those to investigate natural resources, geologic structures, and volcanic features. In particular, the geophysical investigations in the SCP appear to be aimed at individual geologic features or to cover areas of limited extent, without sufficient correlation among the different proposed geophysical investigations. With respect to the drilling program, individual drillholes appear to be specific to single investigations. The potential to obtain additional data relevant to other investigations or geologic features may not be fully considered.

The SCP does not appear to contain a program of surface-based investigations to verify features and conditions that exist in the area of the exploratory shaft. Consideration should be given to evaluating existing data and, if deemed necessary, implementing a program of surface-based geologic and geophysical investigations in the vicinity of the proposed shafts.

2.2.4 Post-closure and Pre-closure Tectonics Programs

Concerns with respect to these two closely related programs are most conveniently presented in one place inasmuch as the concerns apply equally to

both programs. The uncertainties in this area are substantial, and in view of the potentially significant effects of volcanism, faulting, and seismicity on repository design and system performance, high priority should be given to early investigation of the tectonics-related concerns.

One concern is that alternative tectonic models do not appear to be fully considered for the pre- and post-closure programs of investigations for faulting and volcanism. The consequence of this is that because relevant tectonic models are not adequately factored into performance allocation and design considerations, many investigations associated with tectonic features, events, or processes appear not to be appropriately prioritized or sequenced. Tectonic features, events, or processes that could have a significant effect on the waste isolation capability of the repository should be identified promptly, a full range of tectonic models reasonably supported by the existing data base should be considered in planning the tectonics investigations, and high priority should be given to conducting those investigations which can lead to a determination of whether the site has unacceptably adverse conditions based upon assessments of the potential for such features, events, or processes as volcanism, faulting, and seismicity.

Another concern is that the ongoing and proposed studies do not appear to be well integrated or logically sequenced. For example, although volcanism and faulting are often closely associated with each other in a given geologic setting, volcanism studies do not appear to be integrated with faulting studies. As a result, it is uncertain whether relevant tectonic processes will be factored into site characterization assessments related to volcanism.

There also appear to be some situations where geophysical and geologic activities intended to gather data required as input to assessments of faulting may not be completed until well after those assessments have been initiated. In general, it would be prudent for DOE to conduct nonintrusive geophysical and geological activities that will provide information needed to optimize the locations of proposed drillholes and trenches designed to investigate potentially adverse conditions, prior to those intrusive activities.

Still another concern is that characterization, design, and performance parameters related to pre- and post-closure tectonic programs appear to be nonconservative and the rationale for numerical goals appears to be insufficiently supported. The consequence of this is that potential impacts of various parameters on repository performance may be significantly underestimated. The use of fault slip rates, which tend to obscure the episodicity of faulting, consideration of faults as single strands of narrow width rather than as parts of larger fault zones which could have a larger impact on repository performance, and narrow limitations on the identification of "significant faults" within the repository block, which could result in not investigating faults that could have an adverse effect on waste isolation, are examples of this concern. Similar examples exist for volcanism and seismicity.

2.2.5 Human Interference Program

There is a concern that the program of investigations for natural resources assessment is too limited in view of recent publications, models, and discoveries suggesting the presence of mineral and/or hydrocarbon resources in the region near Yucca Mountain. Data gathering activities appear to be directed toward natural resource occurrences in tuff, whereas recognition that resources could reasonably occur in other features or horizons would lead to investigations of other features or horizons potentially favorable to mineral or hydrocarbon resources. Also, proposed investigations do not appear to be integrated with other geological, geophysical, and geochemical site program investigations that could provide data relevant to the natural resources assessment for the Yucca Mountain site.

2.2.6 Thermal and Mechanical Rock Properties Program

The major concern regarding the thermal and mechanical rock properties program is that the expected repository conditions are not fully considered in developing the thermal and mechanical rock properties program. The test plan does not include in situ testing necessary to provide a complete set of rock joint properties needed for design and performance assessment models. Also, there is uncertainty with DOE's dry core drilling technology, which is unproven for the required depth and rock conditions. If sufficient core recovery is unsuccessful, an alternative characterization scheme may have to be considered, which could require significant modifications to the mechanical rock properties program.

2.2.7 Other Site Programs

No major concerns have been identified with the following site programs: climate; erosion; rock dissolution; population density and distribution; land ownership and mineral rights; meteorology; offsite installations; surface characteristics; and preclosure hydrology.

2.3 Repository Program

There is a concern that the site characterization program and ESF design have not been sufficiently coordinated with the conceptual repository design and design information needs and hence that the testing program may be incomplete. For example, since it cannot be determined at this time that the area to be characterized will provide sufficient room for repository development, DOE has identified a designated contingency area. This area, which may be dissimilar to the primary area in its features, is not to be characterized. DOE needs to recognize that if the results of site characterization indicate that the contingency area needs to be included as part of the repository block, DOE will either have to demonstrate that site characterization data already collected is representative of this area or characterize the contingency area.

2.4 Seal Program

A major concern with the sealing program is that necessary data to support the license application may not be available because of certain program assumptions and tentative conclusions. Specifically, although DOE plans to emplace seals, DOE has at least tentatively concluded, on the basis of limited data and analyses, that seals are not needed at the Yucca Mountain site for a repository to meet the performance objectives. The DOE has proposed a seal design concept that relies primarily on an engineered drainage system and the assumption that such a system would be effective over the repository life time. There are uncertainties in the long-term performance of an underground drainage system, a concept not previously supported by any large scale tests. The result is that this concept, which would not be tested until after submittal of the license application, would necessarily be the basis of DOE's license application because, under the assumption that seals are not needed, the strategy of and schedule for seal testing is not oriented toward providing necessary and sufficient data in support of the license application. Hence, if the DOE cannot support the position at the time of license application submittal that seals are not needed to meet the performance objectives, the amount and quality of information that will be available at the time of licensing may be insufficient and inadequate to establish the acceptability of DOE's sealing program. Although the SCP does discuss proposed laboratory testing of certain seal materials, large scale in situ testing of seal concepts, including the engineering drainage system concept, are not planned during site characterization. It is important to test the sealing concepts and identify design tests at an early stage and to analyze their impacts on the ESF layout and design. The schedules presented in the SCP do not present the rationale for a decision regarding the need and bases for developing such testing.

It would be prudent for the DOE, from a strategic point of view, and as a good engineering practice, to plan ahead to evaluate and confirm the role of seals in the overall repository performance. Accordingly it is recommended that the DOE start potentially important large scale in situ tests as early as practicable during site characterization and incorporate such tests in the design of the ESF. The DOE should begin now to ensure the collection of necessary and sufficient data before the license application submittal and should seek further reduction of uncertainties regarding the long-term performance of seals before repository closure.

2.5 Waste Package Program

There are three areas of concern with the waste package program. First, while DOE has revised its CDSCP interpretation of "substantially complete containment" such that the current interpretation is in closer agreement with NRC's interpretation than was the one in the CDSCP, there remain uncertainties about DOE's approach, primarily due to the qualifying phrase "allowing for recognized technological limitations and uncertainties" at the end of the DOE interpretation of "substantially complete containment". What the qualifying phrase means, what its relationship is to the SCP's set of numerical goals, and

what impact this lack of quantitative measure of limitations and uncertainties might have on DOE's compliance demonstration program are matters of concern. Resolution of this uncertainty is the subject of a potential rulemaking by NRC.

Another area of concern is the waste package testing program, which does not include substantive in situ testing. Laboratory testing is laid out in the SCP, but that testing by itself does not seem adequate to resolve the full range of waste package issues, e.g., scale-up effects from small laboratory coupons to full size waste packages; possible synergistic effects of the parameters that can affect waste package corrosion; ability to duplicate the Yucca Mountain environment in the laboratory to the extent that unexpected conditions, processes, or events that could affect the waste package are minimized. Plans for in situ tests should be incorporated into the design of the ESF.

An additional area of concern is the DOE's long-term performance confirmation program, which does not include any tests of waste package performance confirmation. A long term waste package performance confirmation program would provide data to validate to the extent possible the models used to predict the performance of the waste package in the Yucca Mountain environment. It would also provide many years of data that could be factored into the decision-making process related to repository closure. Furthermore, it would help to minimize uncertainties related to long-term waste package performance. Plans for in situ performance confirmation tests should be incorporated into the design of the ESF.

2.6 Performance Assessment Program

Because the post-closure and pre-closure performance assessment programs are quite distinct, each of these is addressed separately.

2.6.1 Post-closure Performance Assessment Program

The objective of the post-closure performance assessment program is to resolve Issue 1.1, Total System Performance Assessment, and the other performance issues. In the SCP a broad strategy is described involving the identification of relationships among performance issues of DOE's Issues Hierarchy and iteratively assessing performance to resolve the performance issues. There are no major concerns regarding this broad strategy, but there are major concerns about its implementation in relation to plans for site characterization to resolve Issue 1.1.

With respect to resolution of Issue 1.1, there are three concerns. Foremost is the concern that total system performance assessments based on increasing amounts of data do not appear to be phased in as site characterization data becomes available. The SCP states that performance assessments will be performed iteratively, but according to schedules in the SCP, the first total system performance assessment does not occur until 1993. This is near the end

of site characterization and is only two years before the date of submittal of the license application. Total system performance assessments should be conducted periodically, starting at an early date, to reevaluate, based on the emerging data, the preliminary licensing strategies and performance allocations. This is how performance assessment can and should be used as a primary basis for demonstrating the ability to meet regulatory criteria and to integrate data gathering activities during site characterization. In particular, total system performance assessments need to be used, together with subsystem (10 CFR Part 60.113) performance assessments, to provide an early and ongoing evaluation of whether any of the various potentially adverse conditions (60.122) significantly affect the ability of the site to meet the 10 CFR Part 60 performance objectives and whether data being gathered are adequate to make this determination. This problem needs early resolution to assure that the site characterization program will provide the data needed for a complete, high-quality license application.

Another concern with respect to Issue 1.1 is that there do not appear to be studies specifically addressing validation of the models used to demonstrate compliance with the quantitative performance objectives. Such studies are needed to ensure coordination of validation activities with site characterization activities. One specific aspect of this concern is that validation studies specifically derived from performance confirmation considerations are not laid out in sufficient detail to assure that an appropriate baseline will be established during site characterization. Furthermore, strategies for long-term tests do not appear to be sufficiently well-developed to assure confirmation of the performance estimates during the performance confirmation period. Radionuclide migration tests and waste package tests are examples of the long-term tests that are needed.

The last major concern with respect to Issue 1.1 is that the scenario analysis supporting performance allocation for total system performance does not assure that the information needed for performance assessment will be acquired. This is the case due to inconsistencies in the use of the term scenario and in the approaches to inclusion or exclusion of scenarios in the construction of CCDFs. Alternative conceptual models are used interchangeably with scenarios, as are initial conditions. "Scenario classes" used in the performance allocation for Total System Performance do not meet the formal definition stated and are inconsistent with the performance measure used. Two very different approaches to scenario definitions are used in the same section of the SCP (Section 8.3.5.13) during discussions of construction of a CCDF and of scenarios considered for characterization. Human intrusion scenarios appear to still be excluded from calculation of the CCDF to demonstrate compliance, despite an NRC comment on the CDSCP indicating that the EPA standard requires consideration of these scenarios.

2.6.2 Preclosure Performance Assessment Program

There are no major concerns regarding the program presented in the SCP to obtain the required information to perform the design and analysis necessary to

determine preclosure radiological safety. However, there is a major concern related to the quality assurance program planned during the preclosure phase. This concern is discussed in Section 2.8, Quality Assurance Program.

2.7 Exploratory Shaft Facility Impacts

The ESF is an especially important subject area of the SCP because of the fact that the ESF will become part of the repository itself if the site is found to be acceptable.

There were three CDSCP objections raised by the NRC staff involving location, design, and construction of the ESF. Two of those objections have been resolved and the third partially resolved. However, the SCP and its references do not demonstrate the adequacy of ESF Title I design control process or the adequacy of the design. As a result, resolution of the problems identified with the Title I design may result in considerable corresponding modifications to the SCP. Therefore, based upon the information provided in the SCP and DAA, there is an objection to DOE's starting construction of the ESF. DOE needs to demonstrate the adequacy of its design control process and of the ESF design.

There are two fundamental bases for this objection. The first is that in the DAA, undertaken by DOE in response to NRC concerns for evaluating the acceptability of the ESF Title I design, DOE did not consider certain concerns critical to NRC acceptance of DAA conclusions. Foremost is the treatment of the applicable 10 CFR 60 requirements in the DAA. Eleven applicable regulations were not considered at all; of the 52 considered applicable, only 22 were considered quantitatively, with some of those inadequately evaluated. The other 30 were considered only qualitatively, despite the fact that some of them are potentially important in evaluating the acceptability of the ESF Title I design. Other problems regarding the DAA are that the adequacy of data used in the Title I design was not thoroughly checked and that the independence of some of the DAA reviewers is open to question.

The second basis for the objection is that the limited analyses presented in the SCP and DAA and the lack of consideration of available information related to important design features leave open a number of significant concerns relating to the ESF Title I design and the design control process. For example, analyses have not been presented to demonstrate that the main test area layout and test durations will permit all currently identified tests to be conducted without interference for the time periods required. Also, an apparent lack of integration of all available geophysical and geological data into the shaft location decision-making process has led to the possibility of potentially adverse structures (e.g., faults) near the shaft locations in violation of the shaft set-back distance from faults established in the report cited in the DAA as the basis for such decisions. The decision-making process appears to have allowed key information about the suitability of the shaft locations to be overlooked. Another design-related concern is that some of the key design criteria (e.g., seismic design basis; effect of liner removal at closure), are not sufficiently justified.

In addition to the above concerns, NRC will not be able to provide final comments on the ESF until it has had the opportunity to review the ESF-related study plans and their essential supporting information.

2.8 Quality Assurance Program

The NRC staff raised an objection to the CDSCP because a quality assurance (QA) program that meets NRC requirements was not in place at that time. That is still the case at the present time. However, NRC and DOE have agreed on an approach for NRC staff acceptance of the program, and DOE is in the process of completing the necessary milestones. While acknowledging this progress, there is an objection to DOE starting new site characterization activities in a particular site characterization program area until DOE completes the applicable milestones related to the QA program for that area and obtains NRC acceptance of them. Once NRC accepts the QA program in a given program area, DOE may proceed with that part of its site characterization program while it continues to complete the milestones needed to obtain NRC acceptance of other parts of the site characterization program.

As a fundamental part of its strategy for baselining its QA program, DOE should fill its QA management positions at the Office of Civilian Radioactive Waste Management and the Yucca Mountain Project Office with permanent full-time individuals with appropriate knowledge and experience. There is a concern that DOE will be impeded in demonstrating the ability to implement the approach to resolve the objection because these positions have not been filled with such individuals.

Another concern with the QA program described in the SCP is that while DOE has committed to implement the appropriate NRC staff guidance for qualifying existing data (i.e., data collected prior to the full implementation of an acceptable QA program), it has yet to submit for staff review its detailed procedures implementing this guidance. It is important for these procedures to be in place so that DOE can qualify some data in accordance with the procedures and, subsequently, NRC staff can evaluate some of the qualified data to determine how appropriately DOE is implementing the procedures. In addition, it is not clear if DOE has eliminated certain tests during site characterization because it has determined that existing data will satisfy the licensing requirements. DOE needs to identify existing data that will have to be qualified.

A major concern related to the QA program planned during the preclosure phase is that neither the SCP nor the Conceptual Design for the Repository (CDR) list any items that will definitely be on the Q-list; rather, tables in the SCP present only potential Q-list items. The primary purpose of developing a Q-list is to assure that those structures, systems, and components essential to prevent or mitigate the release of radionuclides to the environment are subject to appropriate quality control. The approach in the SCP and CDR to the Q-list is to assume a design which is resistant to accidents and hence sufficient to prevent release of radionuclides, thereby precluding the need for design

control or a Q-list. However, this assumption and its resultant conclusion are contrary to the whole purpose of the Q-list and of quality control procedures. Another significant concern related to the Q-list is that the "potential" Q-list and the "preliminary" quality activities list (the combination of which constitutes the scope of the QA program that must meet NRC's QA regulations) have bases for their identification which appear non-conservative in some areas, resulting in incomplete lists. It is recommended that DOE prepare a list of engineered items and barriers associated with handling and isolating high-level waste which have the potential for significantly affecting radiological safety or waste isolation. Items could then be removed from this list as reliable data and suitable analyses show that a low level of, or no, QA is required for such items. What remains on the list would, at any given time, be the Q-list.

Furthermore, a number of items explicitly excluded from these lists should at this time be designated as being under a 10 CFR Part 60 Subpart G (essentially a 10 CFR Part 50, Appendix B) QA program, including the "design" to preclude criticality.

2.9 Use of Radioactive Materials

The only use of radioactive materials in site characterization proposed by DOE is neutron well-logging instrumentation routinely used in geological and hydrological exploration. These radioactive materials are introduced into boreholes and then removed after testing has been completed. The Commission concurs that this proposed use of radioactive material is necessary to provide data needed for the preparation of the environmental reports required by law and to support a license application for a geologic repository at the Yucca Mountain site submitted under the requirements of 10 CFR 60.22.

2.10 Resolution of CDSCP Concerns

Of the five CDSCP objections raised by the NRC staff, two related to exploratory shaft location and construction have been resolved. (However, while the original CDSCP objection concerning shaft location because of concerns with flooding potential has been resolved, part of the basis for the SCP objection related to the ESF is a new concern with the shaft location because of evidence suggesting the presence of faults in close proximity to the proposed locations of the shafts.) The CDSCP objection concerning alternative conceptual models has been partially resolved and is now a comment rather than an objection. While the objection based upon DOE's not having a baselined QA program in place remains an objection, NRC and DOE have agreed upon an approach for the actions required to resolve the objection, and several of the necessary audits and QA plan reviews have already taken place. The objection to the ESF design based upon possible test interferences has been partially resolved, and the unresolved aspects of the objection have been incorporated into the SCP objection regarding the ESF design control process.

Of the 162 comments and questions raised by the NRC staff regarding the CDSCP, 103 were satisfactorily resolved on the basis of the information in the SCP. Of the remaining 59, many were partially resolved. These 59 have been incorporated into SCP concerns and will be tracked as open items until they are resolved by means of information in SCP progress reports, other DOE documents, or by interactions between DOE and the NRC staff.

3.0 SUMMARY OF SCP CONCERNS

3.1 Issue Resolution Process

The SCP commits to a systematic, iterative approach to site characterization. This approach is called the Issue Resolution Strategy. The NRC staff has agreed that this is an appropriate approach; however, there are significant problems with the execution of the approach as documented in the SCP. These problems with execution concern: (1) the consideration of alternative conceptual models, (2) the application of performance allocation, and (3) the proposed Formal Use of Expert Judgment. If corrective action is not taken in a timely manner, these problems may have an impact on the ability of the DOE to provide, at the end of site characterization, sufficient information for a complete and high-quality license application.

The following describes the NRC staff's understanding of the issue resolution strategy described in the SCP.

The Issue Resolution Strategy

Section 8.1.2 of the SCP describes the Issue Resolution Strategy as consisting of four distinct processes: (1) issue identification; (2) performance allocation; (3) data collection and analysis; and (4) issue resolution documentation. These four processes are further divided into eleven distinct steps (see SCP Figure 8.1-1).

Issue identification, as described in Section 8.1.2.1, consists of three steps: (Step 1) identification of regulatory requirements (Step 2) definition of issues (together these derive the issues hierarchy) and (Step 1a) a description of the conceptual models and working hypotheses for the site and of preliminary engineered barrier designs.

Performance allocation, as described in Section 8.1.2.2, is applied to each issue and consists of four steps that provide the rationale for the particular site characterization activities: (Step 3) adoption of a "licensing strategy" (i.e., a statement of the site features, engineered features, conceptual models, and analyses that currently are expected to be relied on to resolve the issue); (Step 4) establishment of performance measures for each of the components identified in the licensing strategy and, for each such performance measure, establishment of a goal and indication of confidence; (Step 5) identification of specific information needs through the identification of the performance (or design) parameters needed to evaluate the performance measures and the establishment of goals and indications of confidence for each such parameter; and (Step 6) identification of directly measurable quantities (generally called characterization parameters) to determine values of the performance or design parameters.

Data collection and analysis, as described in Section 8.1.2.3, is comprised of three steps: (Step 7) conduct investigations, (Step 8) analyze results, and (Step 9) establish that information needs are satisfied.

Issue resolution documentation, as described in Section 8.1.2.4, consists of two steps: (Step 10) use information to resolve issues and (Step 11) document the resolution. The SCP states: "The issue resolution process is intended to be iterative, in that information acquired during site characterization may cause revision to earlier plans and strategies." In particular, SCP Figure 8.1-2 indicates that in Step 9, if continued testing will not increase confidence, then testing strategies should be revised through reallocation of performance; SCP Figure 8.1-3 indicates that in Step 10, if confidence that regulatory criteria are met is not adequate, then testing should continue or a new strategy should be developed. With the exception of Issue 1.1, Total System Performance, the DOE appears to have proposed an iterative implementation of this strategy.

The following describe the NRC's three major areas of concern with the execution of the Issue Resolution Strategy as documented in the SCP.

(1) Alternative Conceptual Models

Alternative conceptual models form a part of the issue identification process. In response to Objection 1 of the CDSCP Point Papers, the discussion of alternative conceptual models has been substantially expanded by including a number of hypothesis testing tables. These tables represent an improvement over the CDSCP in assuring the adequacy of the site program to provide data to distinguish between alternative conceptual models of site performance. There are, however, some concerns regarding the execution of these tables:

- The hypothesis testing tables list a number of factors influencing the "Need to Reduce Uncertainties in Selection of Hypotheses," which is the table column indicating the priority of an investigation(s). There are several instances where all the factors in two different rows are the same, but the "Need to Reduce Uncertainty in Selection of Hypotheses," is different. Thus, the logic used to create the tables is unclear. An exposition of the full rationale of decision-making in this important area is needed.
- In several instances cited in the hypothesis testing tables, it is not clear how the proposed studies will provide the data needed to differentiate among alternative conceptual models.
- Some potentially important alternative conceptual models appear not to be included. For example, there do not appear to be studies aimed specifically at certain important aspects of the geochemical interactions that are unique to the unsaturated zone and that will influence migration of radionuclides.
- The hypothesis testing tables are organized around 10CFR960 subjects rather than issues hierarchy issues, 10CFR60 performance objectives, or repository systems and subsystems. Accordingly, there is a concern that the tables have not been integrated across disciplines.

(2) Performance Allocation

Performance allocation, the second part of the issue resolution strategy has logic gaps in its execution:

- With regard to performance allocation for Total System Performance, Issue 1.1 does not assure that the issue will be resolved because the selected "scenario classes" are inconsistent with the designated performance measures (EPPMs). Also, the selected goals are not adequate to assure that the issue would be resolved.
- Performance allocation for Waste Package Lifetime (Issue 1.4) contains performance measures related to controlled release during the containment period, during which containment should be substantially complete to preserve the multiple barrier concept. Performance measures related to controlled release would be more appropriately applied to the performance allocation for the NRC requirement on fractional release rate (Issue 1.5).

(3) Formal Use of Expert Judgment

The SCP describes a program that appears to rely too heavily on the Formal Use of Expert Judgment (Expert Elicitations) to supply licensing information and data or to substitute for quantitative analyses, because:

- Formal use of expert judgment is proposed to incorporate uncertainty about alternative conceptual models into the CCDF; this approach could lead to an incomplete 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 Part 60.24 that the application be as complete as possible in terms of information reasonably available.

3.2 Site Program

3.2.1 Geohydrology and Preclosure Hydrology Programs

The staff finds DOE has resolved all CDSCP concerns except one about the study to characterize the saturated zone geohydrologic system at the site. Further, the staff has not identified any concerns, consistent with the more general level of detail presented in the SCP, related to the preclosure hydrology program. However, the staff has identified additional concerns about the geohydrology program related to obtaining the information needed for a complete and high quality license application.

General descriptions of the regional and site geohydrologic systems are presented in Chapter 3 of the SCP. These general descriptions represent the current understanding of the geologic features and groundwater flow processes in them considering the present limited data base. These descriptions have been divided into a series of "model elements" as presented in Section 8.3.1.2 of the SCP. Each "model element" represents a specific physical feature, event

or process related to the regional or site geohydrologic system. For each feature, event or process, the current understanding about the feature, event or process is discussed. Initial estimates as to the significance of each feature, event or process to repository performance are made by assessing the relevant performance measure, design or performance parameter and noting the sensitivity of these parameters to each feature, event or process. These assessments form the foundation of the testing program. Thus, incomplete identification of any features, events or processes or the underestimation of their significance with respect to relevant performance measures, design or performance parameters could result in an incomplete testing program. An incomplete testing program could result in an incomplete information base for a license application. Details of the testing program (studies and activities) are provided in Section 8.3.1.2 of the SCP. To determine whether needed information will be provided, the staff has reviewed the information presented in Chapter 3 and Section 8.3.1.2.

There are two categories of technical concerns about the geohydrology site characterization program. First, there are concerns about the completeness of the descriptions of the regional and site geohydrologic systems, considering currently available information, in terms of specific features, events and processes used to plan the field testing program. Also, there is a concern about completely identifying assumptions related to those features, events and processes incorporated in the initial modeling strategies for demonstrating compliance with the performance objectives of 10 CFR Part 60. Second, there are concerns about the sufficiency of certain field studies and activities to test hypotheses about individual features, events and processes of the site geohydrologic system.

With respect to the completeness of the descriptions of the regional and site geohydrologic systems and related modeling assumptions, the staff has identified the following concerns:

- (1) The thermal effects on the geohydrologic system caused by emplaced waste has not been identified as a process to be considered under the geohydrology program or other site programs. As a result, the limited testing program (under the waste package program) may not be sufficient to understand the response of the geohydrologic system to the thermal load;
- (2) A clear distinction is not made between site specific physical features, events and processes and simplifying assumptions about those features, events and processes (that are to be used in initial analyses of the performance objectives of 10 CFR Part 60). As a result, a complete presentation of these modeling assumptions has not been made for the geohydrology program. Thus, planned sensitivity analyses may not be sufficient to provide technical justification for initial modeling strategies (i.e., support all modeling assumptions);
- (3) Similarly, but from a different perspective, current assessments as to whether specific performance measures, design or performance parameters are sensitive to each feature, event or process appear to be judgemental because no specific sensitivity analyses are referenced to support these

assessments. While this is necessary to provide the initial basis for designing the testing program, current plans for sensitivity analyses are focused on a limited set of features, events or processes and are not directed toward a complete and systematic reassessment of the sensitivity of performance measures, design and performance parameters to each feature, event or process as a method for either confirming the correctness of the choice of relevant performance measures, design and performance parameters or making adjustments to the testing program.

With respect to the sufficiency of field studies and activities to test hypotheses about individual features, events and processes, the staff has identified the following concerns:

- (1) Plans to characterize the geohydrologic properties of the Calico Hills unit (a nonwelded tuff unit underlying the repository horizon) are not complete. It is currently hypothesized in the SCP that groundwater flow through fractures and faults within the Calico Hills nonwelded unit is negligible. As a result, the Calico Hills nonwelded unit has been designated the primary natural barrier to groundwater flow and radionuclide transport. However, current plans for characterizing the Calico Hills unit are limited to surface-based studies (vertical boreholes). It is acknowledged in the SCP that the surface-based studies will provide very limited information about the distributions and flow characteristics of fractures and faults in the Calico Hills unit and thus, are of limited use in supporting the hypothesis of negligible flow through faults and fractures. Development of in situ testing in the Calico Hills unit as part of an exploratory shaft facility is being held in abeyance because of a concern that penetration of the unit within the repository block may adversely affect the performance of the site. Alternative approaches (shaft sinking and drifting in the vicinity of the site and various combinations of vertical and angle drillholes and excavation) are being considered. Potential trade-offs between the need to acquire data and the need to preserve site-performance capability are being evaluated by DOE with a risk-benefit analysis. Selection of appropriate test options will be made, and consultations with NRC staff held, prior to initiating testing. Because of the importance placed upon the Calico Hills unit in demonstrating compliance with the performance objectives of 10 CFR Part 60, the staff considers development and completion of an adequate testing plan for the unit to be a significant open item; and
- (2) Activities presented for the study of the saturated zone are not sufficient to characterize groundwater flow paths, flow directions and magnitudes, and boundaries. Data from single-well tests and one multiple-well complex will not be representative of large-scale geohydrologic conditions across the site at scales of importance to repository performance.

3.2.2 Geochemistry and Rock Dissolution Programs

The staff finds DOE has resolved ten comments developed in the CDSCP review. Four CDSCP comments remain unresolved. Eight new comments, all relating to the geochemistry program, have been made. No comments are made relating to the rock dissolution program.

The comments on the geochemistry program are placed in three categories. First, there are concerns about the completeness of the program to consider all potentially important conditions and processes that may exist at Yucca Mountain. Second, there are concerns about the adequacy of some methodologies to determine the values of parameters used to characterize the site. Third, there are concerns about the applicability of laboratory results to the natural environment at the site.

With respect to the completeness of the geochemistry program to consider all potentially important conditions and processes that may exist at Yucca Mountain, the following are examples of concerns identified by the staff:

- (1) "The present approach to modeling chemical interactions in unsaturated rock is to treat the chemistry in a way identical to that of saturated rock, except for modifying the effective porosity" (p. 8.3.1.3-107). This approach would not include consideration of the effects of interactions involving the gas phase. A plausible alternative hypothesis has not been considered in the SCP in which fractures in the unsaturated zone can concentrate radionuclides and enhance transport under episodic conditions.
- (2) The effects of radioactive decay heat, nuclear radiation, and introduced microorganisms on biological sorption are not considered in the SCP.
- (3) Studies are not planned to evaluate the effects of colloid formation from anthropogenic sources from site characterization and construction on sorption and radionuclide transport.

With regard to the adequacy of methodologies for determining the values of parameters that will be used to characterize the site, the following are examples of concerns identified by the staff:

- (1) The thermodynamic properties of zeolites will not be completely defined by solubility techniques due to the metastability of these phases. Additional methods for determining the thermodynamic parameters are recommended.
- (2) Although a stated objective of an activity in the sorption investigation was to derive a mechanistic understanding of the sorption process involving pure minerals, the planned experimental program would not lead to this understanding.

With respect to the applicability of laboratory results to the natural environment at Yucca Mountain, the following illustrate these concerns:

- (1) The application of Kd's derived from the geochemistry investigations to determine retardation may be invalid for certain expected conditions at Yucca Mountain. Thus, although the application of Kd's to modeling retardation may be valid when solute-solid reactions are reversible and fast and the isotherm is linear, it has not been demonstrated that these conditions will hold for all radionuclides considered important in repository performance.
- (2) The determination of some parameters and conditions, such as speciation, kinetics, and matrix diffusion under fracture-flow conditions is not planned. This experimental approach is inconsistent with current knowledge about the site, where it is recognized in the SCP that "minerals that occur in fractures can be very different from those that occur in the adjacent rock matrix. This difference can have important consequences for retardation by sorption, particularly in situations where fracture flow becomes significant" (p. 8.3.1.3-47).

3.2.3 Rock Characteristics and Thermal and Mechanical Rock Properties Programs

The staff has identified several concerns regarding the rock characteristics and thermal and mechanical rock properties programs. The staff is concerned that the programs as described may not yield the necessary site characterization information for a complete license application. The rock-characteristics program is designed to develop a three-dimensional physical properties model and to provide data needed to resolve performance and design issues. Section 8.3.1.4 of the SCP describes the investigations, studies and activities associated with the rock characteristics program. The staff has the following concerns about the program as presented:

- (1) The data to be collected during site characterization may not be complete enough to develop a three-dimensional rock-characteristics model for the entire repository area and to investigate potentially adverse conditions as required by 10 CFR 60.122(a)(2). These concerns were expressed in the NRC CDSCP Point Papers. The SCP contains additional information related to these concerns, but does not completely resolve all of them. For example, the program of drifting in the northern part of the repository block in the proposed ESF, combined with the surface based testing program (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. Based on existing data in the SCP, it appears that geologic conditions in the area of the proposed ESF may not be characteristic of all of the potentially adverse conditions throughout the repository block and that data collected in the proposed area of the ESF cannot be extrapolated to other parts of the proposed repository. Therefore, the NRC staff is concerned that data collected in the proposed exploratory shafts, drill holes, and drifts will not be representative of conditions and processes throughout the repository block.
- (2) With respect to the description of present and expected rock characteristics for site characterization, there is an apparent lack of

coordination between geophysics, drilling, and mapping activities and other site characterization activities. Concerns about the integration of various site characterization activities were previously stated in the NRC staff's CDSCP Point Papers. Although SCP discussions of the integrated drilling program and geophysical investigations program were expanded from those in the CDSCP, the overall concern with respect to the coordination of these programs and, in particular, programs to investigate natural resources, structures, and volcanic features still exist. Specifically, the geophysical investigations program presented in the SCP appears to be generally related only to specific geologic features or to cover areas of limited extent. The need for greater correlation among the different proposed geophysical investigations has not been addressed. In addition, there appears to be little coordination among proposed geophysical investigations and existing geophysical data. Proposed drillholes appear to be specific to single investigations and the potential to obtain additional data relevant to other investigations or geologic features appears not to be fully considered.

The thermal and mechanical rock properties program, presented in Section 8.3.1.15 of the SCP, is intended to provide information on these properties and on the development of design criteria for the underground repository, seals and waste packages. However, it appears that the expected repository conditions are not fully considered in developing the thermal and mechanical rock properties program. The following examples are identified as concerns with the thermal and mechanical rock properties program:

- (1) The SCP does not demonstrate coordination of planned tests with information needed for validation and verification of numerical models used to predict the thermomechanical response of the host rock. For example, the test plan does not include in situ testing necessary to provide a complete set of joint properties needed for design and performance assessment models.
- (2) Activity descriptions presented in the In-Situ Design Verification Section do not include tests to verify design aspects under repository conditions.
- (3) It is not clear what activities are planned to investigate the effects of radiation on thermal and mechanical rock properties.
- (4) There is uncertainty with DOE's dry core drilling technology, which is unproven for the required depth and rock conditions. If sufficient core recovery is unsuccessful, an alternative characterization scheme may have to be considered, which could require significant modifications to the mechanical rock properties program.

3.2.4 Climate and Meteorology Programs

The staff finds DOE has resolved all CDSCP concerns. Further, the staff has not identified any new concerns, consistent with the level of detail presented in the SCP, about these programs.

General discussions of present knowledge about the climate and meteorology of the site and its environs are given in Chapter 5 of the SCP. This chapter also discusses possible procedures and considerations for predicting future climatic variation. For site characterization, the investigations for climate and meteorology have been divided into two separate programs. The program for Climate is described in SCP Section 8.3.1.5, and the Meteorology program is described in SCP Section 8.3.1.12. The Climate program has been designed to provide information and data for both design issues and for the repository performance demonstration and is divided into two major investigations. One investigation is to provide information on past rates and changes in climate for use in predicting future climates, and the other to develop the information needed to evaluate the effects of future climate on the hydrologic system. The meteorology program also contributes to both design and performance issues, but primarily to design issues. It is divided into four investigations: regional meteorology, meteorology in the vicinity of the site surface facilities, locations of population with respect to wind patterns, and the recurrence probability of extreme weather events. Both programs have inter-relations with each other and inter-relationships with other investigations such as the erosion, geochemistry, preclosure hydrology, and geohydrology programs. In general, the staff finds these two programs quite extensive.

3.2.5 Erosion and Surface Characteristics Programs

Only one NRC staff CDSCP concern related to the Erosion and Surface Characteristics site characterization programs was not fully resolved consistent with the more general level of detail necessary for the SCP. Chapter 1 of the SCP presents a general description of the status of knowledge about erosion and geomorphic characteristics and processes relevant to the site. Using information provided in Chapter 1 as a basis, Sections 8.3.1.6 (Erosion Program) and 8.3.1.14 (Surface Characteristics Program) present the proposed site characterization studies and activities and their relationship to other studies that are part of the site characterization program. Aspects of the two programs will provide input to the Hydrology, Climate, and Tectonics Programs, in addition to providing information important to surface facilities locations.

In the CDSCP review of the Erosion Program, NRC staff noted the absence of any activity to evaluate escarpment retreat, valley incision, and uplift/subsidence. In their review of the SCP NRC staff noted the apparent absence of an activity to evaluate escarpment retreat. An evaluation of escarpment retreat, especially a program directed toward the western slope of Yucca Mountain, is important to provide data related to the overall erosion hazard at the site.

3.2.6 Post-closure and Pre-closure Tectonics Programs

In view of the substantial accumulation of evidence related to volcanism, faulting, and seismicity in the geologic setting, the ongoing and planned tectonics programs appear to contain substantial deficiencies. Those are presented below.

- (1) Alternative tectonic models do not appear to be fully considered for the pre-and post-closure programs of investigations for faulting and volcanism. Current hypothesized models for the site do not appear to reflect the uncertainties with respect to alternative models of fault mechanisms and processes and events likely to occur at the site. As a result of the lack of consideration of alternative tectonic models, relevant tectonic models are not adequately factored into performance allocation and design considerations and many investigations associated with tectonic features, events, or processes may not be appropriately prioritized or sequenced. Therefore, consideration should be given to prioritizing investigations giving high priority to those investigations associated with tectonic (including volcanic) features, events, or processes that could adversely impact the determination of site suitability, or lead to a substantial change in the site characterization program.
- (2) Ongoing and proposed studies related to the pre- and post-closure tectonics programs do not appear to be well integrated or in a logical sequence. For example, volcanism studies appear not to be integrated with faulting studies and as a result it is uncertain whether all relevant tectonic processes will be factored into site characterization assessments related to volcanism. The sequencing of some geophysical and geological activities related to faulting may lead to the initiation of data assessments that precede the completion of investigations to gather the data required as input to those assessments.
- (3) Many characterization, design, and performance parameters related to pre- and post-closure tectonic programs appear to be nonconservative and the rationale for numerical goals appears to be inadequately supported. Siting criteria defined in 10 CFR 60.122 (a)(2)(ii) require that the natural conditions at the site be "adequately evaluated using analyses ... and assumptions which are not likely to underestimate" the effect of those conditions. The NRC staff is concerned that the use of nonconservative numerical or areal parameters and goals may result in an underestimation of potential impacts on the performance of the repository. Selected examples of goals or parameters of concern are as follows:
 - The use of fault slip rates alone is not a conservative approach and may result in overly optimistic predictions about the effect of faulting on system performance. Slip rates provide average values of off-set along a fault over a series of events and their use appears to obscure episodicity of faulting and off-set that possibly could occur in a single event.
 - Consideration of faults as single strands of narrow width may result in underestimation of the effects of faulting on the performance of repository facilities. Information presented in Chapter 1 of the SCP indicates that faults in the Yucca Mountain area are not discrete zones of narrow width; therefore, alternative fault models which treat faults as parts of larger fault zones rather than as separate features should be considered.

- Pre-closure characterization parameters for identification and characterization of "significant faults" within the repository block limits faults to be characterized to those with greater than 1 m offset of Quaternary materials or greater than 100 m offset of Tertiary rocks. Adherence to these parameters may result in faults that could have an adverse impact on waste isolation not being investigated.
- Assumptions that future faulting will follow old fault patterns are nonconservative and may result in incomplete evaluations with respect to potential surface offset or fault displacement. Examples that contradict this assumption exist within the geologic setting and should be considered in the definition of criteria for site characterization.
- Reliance on volcanic rate calculations based on cone counts and magma volume appears to be developed largely independent of consideration of underlying volcano-tectonic processes and may underestimate the potential impacts on performance of the repository.
- The tentative goal with respect to the probability of basaltic volcanism appears to be set such that, if met, the site will not meet the EPA standard (40 CFR 191.13). In the area of investigations of basaltic volcanism, the goals and effects of performance allocation need to be reexamined.

The above three general areas of technical concern are consistent with concerns identified in the NRC staff's review of the pre- and post-closure tectonics programs presented in the CDSCP. In view of the potentially significant impacts on repository design and overall system performance, high priority should be given to early resolution of these concerns.

CDSCP concerns about the 10,000 year cumulative slip earthquake concept are restated in a SCP comment. The 10,000 year cumulative slip earthquake concept appears to be a nonconservative approach to characterize fault activity and may result in an underestimation of the seismic hazard. As stated in the SCP, 10,000 years is the minimum earthquake recurrence interval typical for faults in the geologic setting. The 10,000 year cumulative slip earthquake interval concept assumes that the average cumulative slip on a fault over 10,000 years is released in a single event. However, should a longer recurrence interval (e.g., the maximum stated for the area in the SCP is 100,000 years) be assumed, the longer interval will yield larger earthquakes. NRC staff considers that site characterization activities for seismic hazard should be conducted in a manner that will allow for a clear comparison of the 10,000 year cumulative slip earthquake methodology with other alternative methodologies.

The geologic setting of the repository (10 CFR Part 60.2) must be identified and characterized for such purposes as determining and assessing anticipated process and events and potentially adverse and favorable conditions (i.e., 10 CFR Parts 60.112 and 60.122). The SCP mentions components of the geologic setting such as stress regime, seismic geologic setting, and the geologic

setting of the natural resources. However, the geologic setting and its component natural systems are not sufficiently defined in the SCP. Geographic extent, 3-dimensional boundaries and geologic relationships of the natural systems (e.g., stress, seismic, resources) are not explicitly described such as they are known or can be hypothesized to exist. In several cases (involving faulting and volcanism investigations), geographic units of natural features or systems are allocated for purposes of performing relatively detailed investigations; however, the limits appear to be defined with little or no technical rationale and seem arbitrarily restrictive. In order for NRC to evaluate the adequacy of technical information relative to any component system of the geologic setting, plans with schedules are needed to identify, define, characterize and evaluate each component system.

3.2.7 Human Interference and Land Ownership - Mineral Rights Programs

A general description of the regional and site natural resources potential is presented in Chapter 1 of the SCP. Section 8.3.1.9 (Human Intrusion) provides the planned program of study for site characterization related to the assessment of the potential for human activities at or near the site with respect to the potential for exploration or extraction of natural resources.

NRC staff CDSCP concerns noted deficiencies in the program of investigations for natural resources assessment. The SCP comment on the program to assess natural resources reiterates the NRC staff's CDSCP concerns. Bases for staff concerns with respect to natural resources assessment are related to the apparent lack of consideration of alternative natural resource models, a lack of apparent integration with other investigations, and a reliance on out-of-date references and models. The program of investigations for natural resources assessment as presented in the SCP may underestimate possible natural resources and the potential for human intrusion and appears to be directed toward natural resource occurrence in tuff. Alternative resource models, to include resources (mineral and hydrocarbon) associated with Paleozoic rocks, fault zones, veins, and possible plutonic rocks that may be present beneath the site, appear not to be considered. Proposed investigations appear to lack integration with other geological, geophysical, and geochemical investigations and pre-existing data. Data gathering activities such as drilling and geochemical testing may not be directed toward features or horizons favorable to mineralization. Information presented in Chapter 1 of the SCP and in descriptions of the site characterization program in Chapter 8, Section 8.3.1.9, does not reflect recent publications, models and discoveries. In view of the abundance of mining activities in the region near Yucca Mountain, a thorough and well-structured program of site investigations appears warranted.

3.2.8 Population and Offsite Installations, Operations Programs

No concerns with these programs have been identified by the NRC staff.

3.3 Repository Program

The staff has several concerns that involve the level of integration of the site characterization program and the ESF design with the conceptual repository design and design information needs.

Section 8.3.2 of the SCP describes the Repository Program including the Issue Resolution Strategies for Issues 1.11, 2.7, 4.2 and 4.4. For each issue the SCP outlines the information needs and the various design activities required to collect the necessary information. A significant amount of integration is required between the ESF and repository design and the site characterization program. The staff is concerned that current levels of integration may result in an incomplete testing program.

The following examples are identified as staff concerns regarding integration between the site characterization program and ESF design and, the conceptual repository design and design information needs.

- (1) It has not been demonstrated that the area needed for repository development, judged to be 1420 ± 210 acres, will be sufficient based on the stated area requirements of the characterization area. Further, the 300 acres set aside for contingency purposes may not be representative of the repository development area and thus the current test plan may not obtain the necessary information.
- (2) The selection of a waste emplacement mode (horizontal vs. vertical orientation) is scheduled for September 1989. The staff is concerned that this decision will be made without considering the results of the waste package emplacement/retrieval equipment demonstrations (beginning 12/91), field demonstrations of proof of concept "for horizontal drilling and waste emplacement," and site investigations needed to support development of a prototype boring machine.
- (3) The site characterization test program does not seem to have incorporated an appropriate fault displacement design basis. The staff is concerned that information necessary to evaluate this design basis will not be collected during site characterization in a timely manner and thus the license application may not be complete.

3.4 Seals Program

Concerns on DOE's seal program stem from the technical basis developed by DOE's preliminary performance assessment which concludes, based on limited data, that seals are not necessary to meet the performance objectives. These preliminary conclusions have been used as a basis not to place seals on the DOE's Q-list. The DOE's sealing concepts presented in the SCP are based on placing reliance on engineered drainage system and the assumption that such a system would be effective over the repository life time. Such untested concepts would be the bases of DOE's license application under the proposed plans. This is not an acceptable approach.

The staff's strategy for the review of DOE's seal program is based on staff Technical Positions on: (1) Sealing and (2) Q-list methodology. The staff's guidance to DOE has been (1) sealing should be assumed necessary until proven otherwise; (2) seals should be placed on the Q-list until it can be convincingly shown that seals are not required to meet the performance objectives; and (3) testing and analyses of seal and drainage concepts should be started as early as practicable taking into account both gaseous and water pathways.

Although the SCP presents discussions on proposed laboratory testing of certain seal materials, there is concern that the amount and quality of information that will be available at the time of licensing may be insufficient to make convincing arguments on the adequacy of DOE's sealing program.

While the staff realizes that large scale in situ testing of seal design may be started as a part of performance confirmation testing after license application submittal, it is extremely important to test the sealing concepts and identify design tests at an early stage and to analyze their impacts on the ESF layout and design. In addition, there is a major concern with respect to the potential for test-to-test interference even without taking into account such large scale in situ tests of seals and drainage concepts. The current schedules presented in the SCP do not present the rationale for a decision regarding the need and bases for developing such testing.

From a strategic point of view, and as a good engineering practice, it would be prudent for DOE to plan ahead to evaluate and confirm the role of seals in the overall repository performance. Among the plans to consider are the advantages of starting large scale in situ tests as early as practicable during site characterization. The DOE needs to begin now to ensure the collection of necessary and sufficient amount of data before the license application submittal and should seek further reduction of uncertainties regarding the long-term performance of seals before repository closure.

3.5 Waste Package Program

The staff's review of the SCP resulted in the development of 16 comments and 20 questions related to EBS/waste package issues. By way of comparison, the staff had 16 comments and 2 questions from the review of the CDSCP, including the significant comment on DOE's interpretation of the term "substantially complete containment" (SCC). Out of the 16 CDSCP comments and 2 questions, 10 comments and both questions were satisfactorily resolved in the SCP.

The staff's review of the SCP was focused primarily on (1) the general descriptions of the waste package and near-field environment in Chapter 7, (2) the waste package program and compliance demonstration strategy in Section 8.3.4, (3) the waste package performance issues in Section 8.3.5.9 and Section 8.3.5.10, and (4) the performance confirmation program in Section 8.3.5.16. The review resulted in three general areas of concern with the EBS/waste package site characterization program. Those areas of concern relate to (1) DOE's revised interpretation of the "containment" rule and related waste package performance goals, (2) the lack of a substantive waste package in situ

testing program, and (3) the lack of a long term performance confirmation program for the waste package. Each of these three areas of concern is discussed in detail below.

Substantially Complete Containment

In reviewing the CDSCP, the staff strongly disagreed with DOE's design objectives for the waste package which reflected their interpretation of the meaning of substantially complete containment. The design objectives are important because they are used as guides for the waste package research and testing program which is designed to develop the data and related models to support a demonstration of compliance with the containment requirement. Accordingly, deficiencies in the waste package research and testing program portend inadequacies in the data base, model development and associated assessments for demonstrating compliance with the rule.

In the SCP, the DOE revised its interpretation of "substantially complete containment." This interpretation is stated in Section 8.3.5.9 as follows: "The DOE understands substantially complete containment to mean that the set of waste packages will fully contain the total radionuclide inventory for a period of 300 to 1,000 years following permanent repository closure, allowing for recognized technological limitations and uncertainties." In addition, "Implementation of this understanding will be based solely on reliance on the waste package as the major component of the engineered barrier system." The SCP has established goals and laid out plans for tests to acquire the data to satisfy the requirements on SCC, controlled release rate and performance confirmation.

The staff considers that the revised interpretation is an indication that DOE has taken a more conservative interpretation of the regulatory requirement, one more consistent with the staff's interpretation. However, the SCP has not demonstrated that this revised interpretation has sufficiently altered its plans for what must be demonstrated for compliance, or its strategy for demonstrating compliance. Therefore, the staff considers it important to reach a mutual understanding that the information developed during site characterization, and the approach to limit uncertainties in the prediction of service life, can be expected to generate enough information to satisfy the regulatory requirement for SCC. To accomplish this, the staff needs to reach an understanding of the following:

- (1) The meaning of "recognized technological limitations and uncertainties".
- (2) The relationship between the SCP's set of numerical goals and the "limitations and uncertainties".
- (3) The impact introduced by this lack of quantitative measure of limitations and uncertainties on DOE's compliance demonstration program.

The staff's evaluation above is supported by the following observations:

- (1) Some of DOE's performance goals related to their interpretation of substantially complete containment are considered to be inconsistent with the intent of the rule.
- (2) There are few in situ waste package tests planned to acquire data for long term performance predictions.
- (3) Only short duration tests (few years) are planned for its performance assessment models. While these tests may be appropriate to support the license application, the staff takes note that the entire time period from present to the decision on closure (not just the time period until license application for construction authorization) is available for DOE to address the reduction of technological limitations and uncertainties regarding the adequacy of design for containment and prediction of release rate performance. By not initiating in situ tests during site characterization, the opportunity for collecting many years' data on waste package performance would be lost.

Staff recommends NRC and DOE interact to resolve the issues above.

In Situ Testing Program

The DOE's existing waste package testing program incorporates very few in situ tests and the predominantly laboratory testing described in the SCP does not seem adequate to resolve the full range of waste package issues. Those issues include scale-up effects (i.e., the representativeness of data from small scale laboratory coupons to full size waste packages), possible synergistic effects of all parameters which can affect long term waste package integrity and performance and the ability of DOE to duplicate the Yucca Mountain environment in the laboratory to guard against "surprises" or the "unexpected" in the testing program. The staff considers that in situ testing is a desirable, and perhaps necessary, complement to the laboratory testing currently planned for waste package development and can address those issues not easily resolved in the laboratory. Accordingly, the staff is recommending that DOE establish a proper balance of in situ and laboratory testing for the waste package development program.

Performance Confirmation Program

In the review of the DOE performance confirmation program, the staff noted that the DOE has plans for a number of long term tests which will extend beyond site characterization activities but none of the tests were related to waste package performance confirmation and the staff has determined the program is deficient in this area. The value of a long term performance confirmation program for the waste package is that, in addition to validating the models utilized to predict the performance of the waste package in the Yucca Mountain environment, it can provide decades worth of data which can be factored into the decision-making process related to repository closure. In this regard, even "null" results would be useful information in this process. Additionally, such

a program will help to minimize uncertainties related to waste package performance, consistent with the requirements of 10 CFR 60.140. The staff recommends that a long term waste package performance confirmation program be established which recognizes the benefits that such a program can provide. The DOE should also recognize the relationship of this recommendation with the recommendation cited above for an in situ testing program.

3.6 Performance Assessment Program

3.6.1 Post-Closure Performance Assessment

The NRC staff's review of post-closure performance assessment focused on the performance assessment strategy described in Section 8.3.4.8 and the plans for implementation of this strategy described in Sections 8.3.5.9 through 8.3.5.20. As stated in the SCP (p. 8.3.5.8-1): "The primary objective of the Yucca Mountain Project post-closure performance assessment program is to resolve Key Issue 1 in the issues hierarchy, which is ... 'Will the mined geologic disposal system at Yucca Mountain isolate the radioactive waste from the accessible environment after closure in accordance with the requirements set forth in 40 CFR Part 191, 10 CFR Part 60, and 10 CFR Part 960?'"

The strategy for post-closure performance assessment described in Section 8.3.5.8 involves identifying relationships among performance issues of the Issues Hierarchy and iteratively assessing performance to resolve the performance issues. The performance assessments are described as consisting of five major steps: (1) compile site data for in situ conditions, material properties, physical processes, and structural boundaries; (2) define scenarios and boundaries for calculations; (3) develop, test, and validate conceptual and numerical models that describe the physical systems to be assessed; (4) calculate values for the performance measures; and (5) assess uncertainty in predicted performance. As the performance assessments are conducted, the strategy calls for determinations of the need to iterate steps on the basis of whether there is a basis for the NRC to find "reasonable assurance" that the 10CFR60 performance objectives are met.

Based on its review the staff has no concerns regarding the broad strategy described in Section 8.3.5.8. The staff does have concerns regarding implementation of the strategy as it relates to Issues 1.1 and 1.6.

Issue 1.1, Total System Performance Assessment

The staff, has concerns about implementation of this strategy as it relates to plans for site characterization to resolve issue 1.1, Total System Performance. The staff's concerns are in three general areas: (1) use of performance assessments, (2) the validation program, and (3) the scenario analysis. These concerns are discussed below.

(1) Use of Performance Assessment

Although the SCP states that, in general, performance assessments will be performed iteratively, the first total system performance assessment as

presently scheduled, does not occur until near the end of site characterization (1993). The total performance assessments should be executed periodically, starting at an early date, to evaluate data acquired during the site characterization program and to reevaluate the preliminary licensing strategies and performance allocations. Total system performance assessments based on increasing amounts of data do not appear to be phased in as site characterization data became available. Thus, performance assessments do not appear to be used as a primary basis for demonstrating the ability to meet regulatory criteria and to integrate data gathering activities during site characterization. This potentially serious deficiency needs early resolution to assure that the site characterization program will provide the data needed for a complete, high-quality license application.

(2) Validation Program

A significant aspect of the decision on licensing will depend on the projections of performance for 10,000 years. These projections require interdisciplinary analyses, because what might be a satisfactory model validation program for any one discipline may not be sufficient for these multidisciplinary models.

There do not appear to be any studies specifically addressing validation originating from the considerations of validation in Section 8.3.5.20. There are a number of references to validation studies, but there does not appear to be a systematic, balanced, and prioritized approach. The studies specifically derived from performance confirmation considerations are not laid out in sufficient detail to assure that an appropriate baseline will be established during site characterization.

Plans for long-term tests do not appear to be sufficiently well developed to assure a complete, high-quality license application and confirmation of the performance estimates during the performance confirmation period. Examples of long term tests needed are: migration experiments and waste package tests.

Scenario Analysis

The scenario analysis supporting performance allocation for total system performance does not assure that information needed for performance assessment will be acquired.

"Scenario classes" used in the performance allocation for Total System Performance do not meet the formal definition stated and are inconsistent with the performance measure used (EPPM's). That is, the "scenario classes" used for total system performance assessment are broadly based on release mechanisms, while the performance measures used are derived from the very precise definition of scenarios as a sequence of events.

Alternative conceptual models are used interchangeably with scenarios. Examples of alternative conceptual models inappropriately treated as scenarios are: (1) the occurrence of horizontal flow, while the preferred site model assumes vertical flow and (2) various corrosion mechanisms, when any or all

mechanisms may operate for a variety of scenarios. Initial conditions are also used interchangeably with scenarios. An example is faulty emplacement of waste packages, which establishes an initial condition or range of initial conditions for the repository.

Quite different approaches to scenario definitions are used in the extensive mathematical discussion about constructing a CCDF in Section 8.3.5.13 and the extensive discussion of scenarios considered for characterization (later in the same section).

The DOE response to NRC's comments on the CDSCP indicates that human intrusion scenarios will be excluded from calculating the CCDF to demonstrate compliance (or, alternatively, to guide site characterization), although the SCP itself is unclear in this regard. In the NRC's CDSCP comments it was indicated that compliance with the EPA standard requires consideration of these scenarios and that arbitrary exclusion of these scenarios may result in an incomplete license application.

Issue 1.6, Pre-Waste-Emplacement Groundwater Travel Time

All CDSCP concerns about the planned approach to demonstrate compliance with the groundwater travel time performance objective of 10 CFR Part 60 have been resolved. However, the staff has identified additional concerns about the planned approach related to the information needed for a complete and high quality license application.

Three concerns have been identified by the staff. These include:

- (1) The planned approach to delineate the boundary of the disturbed zone does not consider all physical or chemical properties that will have changed as a result of heat generated by emplaced waste to determine which resultant changes of properties may have a significant effect on repository performance;
- (2) The proposed method for constructing cumulative distribution curves (cdf's) for groundwater travel time by weighting "alternative conceptual models" is inappropriate and would not provide exhaustive assessments of groundwater travel time for staff review; and
- (3) All assumptions are not identified about features, events and processes related to the geohydrologic system, incorporated into the initial modeling strategy for groundwater travel time. It is important to identify both those assumptions that are believed to be technically justified based on currently available information and those that require additional support to determine whether plans to obtain needed information are complete.

3.6.2 Preclosure Performance Assessment

In general, the SCP recognizes that requirements for preclosure radiological safety for a geologic repository are similar to the requirements for such

nuclear facilities as independent spent fuel storage facilities and those portions of nuclear power plants where spent fuel is handled. This has resulted in the recognition that procedures and regulatory guides which were developed to direct the investigation and analysis of similar situations in other nuclear facilities are applicable to help guide at least the surface portion of the preclosure repository program. As is reflected in such places as Tables 8.3.5.3-2, 8.3.5.4-2, and 8.3.5.5-2, this approach has resulted in a list of investigations and information needs, which should result in sufficient information to perform the design and analysis necessary to determine preclosure radiological safety.

The major preclosure radiological safety concern is related to the quality assurance program planned during the preclosure phase. Both Table 6-18 and Table 6-32 in Chapter 6 of the SCP present only potential Q-List items. Neither the Conceptual Design of the Repository (CDR) nor the SCP list any items which will definitely be on the Q-list. It appears that the main basis for this situation is that the radionuclide release calculations assumed that the design was sufficient to either prevent releases in excess of regulatory limits, or only allow releases in excess of regulatory requirements in very low probability situations. This approach becomes apparent in such places as Table 2-1 of Appendix F of the CDR. In this table the "dispersion resistance" of radionuclides, the relative likelihood of release, in different areas of the repository is estimated. In the access area, the receiving and inspection area, and during the early stages of handling in the cask receiving and preparation area, dispersion resistance is assumed to be high because the radioactive material is assumed to still be within the transportation casks, and these casks are postulated to withstand accidents. The casks, however, are not included on the Q-List. This becomes a concern even beyond the requirements of 10 CFR Part 60, because the transportation casks will have to be designed to comply with 10 CFR Part 71 which requires a Quality Control program. This approach of assuming a design which is resistant to accidents is reflected throughout the SCP and CDR, such as on page 4-22 of Appendix F, where credit is being taken for safety factors included in the design, including the fact that the hot cells are assumed to withstand earthquake loading, and the fact that locking devices are assumed to be present to prevent a crane from derailing during an earthquake. In these last examples, as the previous example, these items are also not on the Q-list.

As has been discussed in the summary of concerns related to Quality Assurance, it is the NRC staff position that those items for which DOE is taking credit in the prevention or mitigation of release of radionuclides should be subject to a 10CFR50, Appendix B (or equivalent) QA program. The primary purpose of developing a Q-list is to assure that those structures, systems and components which are essential to prevent or mitigate the release of radionuclides to the environment are subject to appropriate quality assurance. If it is assumed that the design is sufficient to prevent release of radionuclides, and hence that there is no need for quality assurance of the design as it is developed, the whole purpose of the Q-list and quality assurance procedures is negated. Section 8.6.4.2.1 of the SCP commits the DOE to review the procedures used to develop the Q-list. Upon completion and submission of this documentation, the NRC staff will review the systems, structures and components present on the

Q-list to determine if preclosure radiological safety concerns have been addressed. In general, due to the similarity between the surface facilities of a MRS and a geologic repository, the NRC staff suggests that NUREG-1168, Staff Evaluation of U.S. Department of Energy Proposal for Monitored Retrievable Storage (US NRC, 1986), could provide guidance to help determine which systems, structures and components of the surface facilities could be considered important to safety. The items so identified should be considered for inclusion on the Q-list. While NUREG-1168 can only be considered applicable for surface facilities, a similar type of analysis of such subsurface items as the ventilation system and HEPA filters from the subsurface should also be considered by DOE.

Other NRC concerns related to preclosure radiological safety are reflected in the SCP discussion concerning the use of 10 CFR Part 20 and how certain information needed to perform calculations to determine compliance with Part 20 will be obtained. In several instances, the SCP is unclear as to how DOE is interpreting the requirements of 10 CFR Part 20. The staff comments related to this concern are meant to assure that all applicable provisions of Part 20 will be considered by DOE in the design and analysis.

The main NRC concerns related to retrieval are that the SCP does not address the requirements of 10 CFR Part 60.132(a) and that there is no analysis provided to support the contention that the vertical emplacement boreholes will remain stable during the retrieval period. These are concerns primarily because there appear to be no plans to conduct tests to determine the effects of radiation on mechanical rock properties.

3.7 Potential Impacts of Site Characterization Activities

3.7.1 Exploratory Shaft Facility And Impacts

The SCP and its references demonstrate neither the adequacy of ESF Title I design control process, nor the adequacy of the design. Issues were raised prior to NRC review of the SCP regarding DOE's exclusion of critical regulatory requirements in the design, resulting in deficiencies in the design and uncertainties regarding the effectiveness of the design control process. Resolution of the problems identified with the Title I design may result in considerable corresponding modifications to the SCP. The bases for this concern are as follows:

- (1) The Design Acceptability Analysis (DAA) undertaken by DOE in response to NRC concerns for evaluating the acceptability of the ESF Title I design, did not appropriately consider certain concerns necessary for NRC acceptance of DAA conclusions. The following are some examples:
 - Independence of the reviewers is in question. Five reviewers who were certified not to have contributed significantly to the ESF Title I design and SDRD (sub-system design requirements) are identified as authors, reviewers, and/or contributors to specific documents which were input documents to the ESF design.

- Neither the design nor the subsequent DAA considers (qualitatively or quantitatively) 11 of the applicable 10 CFR 60 requirements.
 - Of the 52 requirements (10 CFR Part 60) considered in the DAA to be applicable to the ESF design, only 22 were considered quantitatively. The remaining were said to have been considered qualitatively. Included in the remaining 30 are the requirements of Subpart F (Performance Confirmation Program) which is to be started during site characterization. Some of these requirements are potentially important in evaluating the acceptability of the ESF Title I design.
 - d. Of the 22 requirements that were considered quantitatively, inadequacies have been identified by NRC staff. For example, in considering the regulatory requirement related to alternatives to major design features important to waste isolation (60.21(c)(1)(ii)(D)), the analysis presented was limited and incomplete.
 - DAA did not thoroughly check the adequacy of data used in the ESF Title I design.
2. Additional concerns regarding the ESF Title I design and the design control process stem from the limited analyses presented in the SCP and DAA and a lack of consideration of available information related to important design features. Examples include:
- There is apparent lack of integration of all available geophysical and geological data into the shaft location decision making process. In the DAA, the Bertram (1984) report is cited as the basis for decisions regarding shaft set-back distance from faults (stated as exclusion of all locations within 100 feet of faults, DAA p. 2-26 and 2-29); however, other reports such as Smith and Ross (1982) and the letter from Dixon to Veith (1982) note the presence of possible adverse structures whose presence may violate the parameters cited in Bertram. Therefore, the decision making process appears to have overlooked key information about the suitability of the shaft locations.
 - Analyses have not been presented to demonstrate that the main test area layout and test durations will permit all tests to be conducted for the time periods required without interference.
 - A rationale has not been presented to demonstrate that in situ waste package testing will not be needed during site characterization to reduce uncertainties associated with long term waste package performance prediction.
 - As was discussed in Section 3.2.3 (Rock Characteristics Program), 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 ensure that observations made and data collected will be representative of conditions and processes throughout the repository block.

- Some of the ESF design criteria are not sufficiently justified. Examples include: (a) Seismic design basis, (b) ES-1 drainage volume and long-term drainage reliability, and (c) effect of liner removal at closure.

In addition to the above concerns, NRC will not be able to provide final comments on the ESF until it has had the opportunity to review the ESF-related study plans and their essential supporting information.

3.7.2 Surface - Based Activities and Impacts

The staff's review of DOE's surface-based activities described in Section 8.4.2.2 of the SCP found no areas of concern with respect to the long-term isolation of waste.

3.8 Quality Assurance Program

With respect to the QA program for the Yucca Mountain Project, the staff's objection to the CDSCP remains open as DOE and its key contractors have not as yet completed the development and implementation of QA programs that meet NRC requirements. Three of the five CDSCP comments have been resolved, however. The two unresolved comments relate to the use of data in licensing that was collected before complete implementation of the QA programs and the items and activities covered by the Commission's QA requirements.

Section 8.6 of the SCP describes the quality assurance program to be applied to site characterization activities, including exploratory shaft design and construction, as well as the QA measures applied to site exploration activities before site characterization. It also describes the items and activities which are subject to NRC QA requirements and references sections 6.1.4 and 6.1.5 of the SCP. These sections contain the general methodology used to identify the items important to safety and engineered barriers important to waste isolation, which comprise the Q-list, and activities associated with the assessment of the natural barriers important to waste isolation, which comprise the quality activities list.

DOE has committed to developing a QA program for site characterization which meets the Commission's requirements so that work performed during this phase is appropriately controlled to assure validity and can be used in NRC licensing. DOE and NRC agreed on an approach for staff acceptance of the program after the CDSCP objection was published, and DOE is in the process of completing the necessary milestones. The staff QA objection on the SCP states that DOE should complete the applicable milestones and obtain NRC acceptance of them before proceeding with new site characterization activities. The objection will remain open until the milestones are completed. The objection can be lifted for individual program areas if DOE demonstrates and NRC agrees on the acceptability of the QA program for a specific program area. The QA objection

also conveys the staff's concern that DOE will be impeded in demonstrating the ability to implement the agreed upon 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.

Two concerns previously identified in the CDSCP comments have been identified with the program described in Section 8.6 of the SCP. First, for existing data to support the license application (i.e. data collected prior to the full implementation of the QA program), DOE has committed to implementing the appropriate staff guidance for qualifying the data, but has yet to submit for staff review its detailed procedures implementing this guidance. These procedures are under development and are expected to be submitted in the near future. After review of these procedures, the staff will also evaluate selected data qualified in accordance with the procedures. In addition, it is not clear if DOE has eliminated certain tests/experiments during site characterization because it has determined that existing data will satisfy the licensing requirements. DOE needs to identify existing data by activity that needs to be qualified.

Second, the "potential" Q-list and the "preliminary" quality activities list (the combination of which constitutes the scope of the QA program which must meet NRC's QA regulations), have bases for their identification which appear non-conservative in some areas, resulting in incomplete lists. The staff recommends that an item or activity be "Q" listed until shown otherwise. The NRC staff believes that a number of items explicitly excluded from these lists should at this time be designated as being under a 10 CFR Part 60 Subpart G (essentially a 10 CFR Part 50, Appendix B) QA program, including the "design" to preclude criticality.

The staff also has some quality assurance concerns with the Design Acceptability Analysis (DAA) which are discussed in Section 3.7.1, "Exploratory Shaft Facility and Impacts."

TABLE 1
STATUS OF CDSCP POINT PAPERS

| <u>CDSCP POINT PAPER</u> | <u>STATUS</u> | <u>SCP POINT PAPER(S) INCORPORATING UNRESOLVED CONCERNS</u> |
|--------------------------|-------------------------|---|
| OBJECTION 1 | UNRESOLVED ¹ | SCP/NAE/COM/7 |
| 2 | RESOLVED | |
| 3 | UNRESOLVED | DCG/OBJ/100/4 |
| 4 | RESOLVED | |
| 5 | UNRESOLVED | QA-1 |
| COMMENT 1 | UNRESOLVED | DCG/COMM/1N/4 |
| 2 | RESOLVED | |
| 3 | UNRESOLVED | KCC/COM17 |
| 4 | UNRESOLVED | SCP/PPB/COM/6 |
| | | SCP/PPB/COM/1 |
| | | SCP/PPB/COM/2 |
| 5 | RESOLVED | |
| 6 | RESOLVED | |
| 7 | RESOLVED | |
| 8 | RESOLVED | |
| 9 | RESOLVED | |
| 10 | RESOLVED | |
| 11 | RESOLVED | |
| 12 | RESOLVED | |
| 13 | UNRESOLVED | NMC/COM/13 |
| 14 | RESOLVED | |
| 15 | RESOLVED | |
| 16 | RESOLVED | |
| 17 | UNRESOLVED | JWB/COM/3 |
| 18 | UNRESOLVED | JWB/COM/4 |
| 19 | RESOLVED | |
| 20 | UNRESOLVED | JWB/COM/4 |
| 21 | RESOLVED | |
| 22 | UNRESOLVED | JWB/COM/14 |
| 23 | RESOLVED | |
| 24 | RESOLVED | |
| 25 | RESOLVED | |
| 26 | UNRESOLVED | SCP/AI/COM/4 |
| 27 | RESOLVED | |
| 28 | UNRESOLVED | KIM/COM/30 |
| 29 | RESOLVED | |
| 30 | UNRESOLVED | DCG/COMM/60N/4 |
| 31 | RESOLVED | |
| 32 | RESOLVED | |
| 33 | RESOLVED | |
| 34 | RESOLVED | |
| 35 | UNRESOLVED | SCP/CA/COM/5 |
| 36 | UNRESOLVED | JST/COM/4/4 |

¹Partially resolved; now a comment rather than an objection

| <u>CDSCP POINT PAPER</u> | <u>STATUS</u> | <u>SCP POINT PAPER(S) INCORPORATING UNRESOLVED CONCERNS</u> |
|--------------------------|---------------|---|
| COMMENT 37 | UNRESOLVED | KIM/COM/1 |
| 38 | UNRESOLVED | KIM/COM/13 |
| 39 | UNRESOLVED | SCP/CA/COM/2 |
| 40 | RESOLVED | SCP/CA/COM/2 |
| 41 | RESOLVED | |
| 42 | RESOLVED | |
| 43 | UNRESOLVED | DCG/COMM/1N/4 |
| 44 | UNRESOLVED | DCG/COMM/1N/4 |
| 45 | UNRESOLVED | DCG/COMM/45N/4 |
| 46 | RESOLVED | |
| 47 | RESOLVED | |
| 48 | RESOLVED | |
| 49 | UNRESOLVED | SCP/AI/COM/2 |
| 50 | UNRESOLVED | JST/COM/3/3 |
| | | JST/COM/1/1 |
| | | JST/COM/2/A |
| | | JST/COM/2/B |
| | | AI/COM/3 |
| | | MEB/COM/1 |
| 51 | UNRESOLVED | |
| 52 | UNRESOLVED | |
| 53 | RESOLVED | |
| 54 | RESOLVED | |
| 55 | RESOLVED | |
| 56 | RESOLVED | |
| 57 | RESOLVED | |
| 58 | RESOLVED | |
| 59 | RESOLVED | |
| 60 | RESOLVED | |
| 61 | RESOLVED | |
| 62 | UNRESOLVED | KIM/COM/33 |
| 63 | RESOLVED | |
| 64 | UNRESOLVED | DCG/COM/64/4 |
| 65 | UNRESOLVED | DCG/COM/65/4 |
| 66 | UNRESOLVED | DCG/QUE/66/4 |
| 67 | RESOLVED | |
| 68 | RESOLVED | |
| 69 | RESOLVED | |
| 70 | UNRESOLVED | DCG/COM/70/4 |
| 71 | RESOLVED | |
| 72 | UNRESOLVED | DCG/COM/72/4 |
| 73 | UNRESOLVED | KCC/COM/18 |
| 74 | RESOLVED | |
| 75 | RESOLVED | |
| 76 | RESOLVED | |
| 77 | UNRESOLVED | KCC/COM/12 |
| 78 | RESOLVED | |
| 79 | RESOLVED | |
| 80 | UNRESOLVED | KCC/COM/13 |
| 81 | RESOLVED | |
| 82 | UNRESOLVED | KCC/COM/19 |

| <u>CDS CP POINT PAPER</u> | <u>STATUS</u> | <u>SCP POINT PAPER(S) INCORPORATING UNRESOLVED CONCERNS</u> |
|-------------------------------|---------------|---|
| COMMENT 83 | RESOLVED | |
| 84 | RESOLVED | |
| 85 | RESOLVED | |
| 86 | RESOLVED | |
| 87 | RESOLVED | |
| 88 | RESOLVED | |
| 89 | RESOLVED | |
| 90 | UNRESOLVED | SCP/NAE/COM/18 |
| 91 | UNRESOLVED | SCP/NAE/COM/1 |
| 92 | UNRESOLVED | SCP/NAE/COM/16 |
| 93 | UNRESOLVED | SCP/NAE/COM/13 |
| 94 | UNRESOLVED | SCP/NAE/COM/4 |
| 95 | UNRESOLVED | JST/COM/4/4 |
| 96 | RESOLVED | |
| 97 | RESOLVED | |
| 98 | RESOLVED | |
| 99 | RESOLVED | |
| 100 | UNRESOLVED | KIM/COM/30 |
| 101 | RESOLVED | |
| 102 | RESOLVED | |
| 103 | UNRESOLVED | DCG/COM/103/4 |
| 104 | RESOLVED | |
| 105 | RESOLVED | |
| 106 | UNRESOLVED | QA-3 |
| 107 | RESOLVED | |
| 108 | UNRESOLVED | QA-2 |
| 109 | UNRESOLVED | KCC/COM/16 |
| 110 | RESOLVED | |
| QUESTION 1 | RESOLVED | |
| 2 | UNRESOLVED | SCP/PPB/COM/2 |
| 3 | RESOLVED | |
| 4 | RESOLVED | |
| 5 | RESOLVED | |
| 6 | RESOLVED | |
| 7 | RESOLVED | |
| 8 | RESOLVED | |
| 9 | RESOLVED | |
| 10 | RESOLVED | |
| 11 | RESOLVED | |
| 12 | RESOLVED | |
| 13 | UNRESOLVED | SCP/CA/QUES/13 |
| 14 | RESOLVED | |
| 15 | RESOLVED | |
| 16 | RESOLVED | |
| 17 | RESOLVED | |
| 18 | RESOLVED | |
| 19 | RESOLVED | |
| 20 | UNRESOLVED | KIM/COM/18 |

CDSCP POINT
PAPERSCP POINT PAPER(S)
INCORPORATING UNRESOLVED
CONCERNS

| <u>QUESTION</u> | <u>STATUS</u> | |
|-----------------|--------------------|----------------|
| 21 | RESOLVED | |
| 22 | RESOLVED | |
| 23 | RESOLVED (Deleted) | |
| 24 | RESOLVED | |
| 25 | UNRESOLVED | DCG/QUES/25N/4 |
| 26 | RESOLVED | |
| 27 | RESOLVED | |
| 28 | RESOLVED | |
| 29 | RESOLVED | |
| 30 | RESOLVED (Deleted) | |
| 31 | RESOLVED | |
| 32 | UNRESOLVED | MEB/COM/2 |
| 33 | UNRESOLVED | SCP/AI/COM/4 |
| 34 | RESOLVED | |
| 35 | RESOLVED | |
| 36 | RESOLVED | |
| 37 | UNRESOLVED | DCG/QUES/37N/4 |
| 38 | RESOLVED | |
| 39 | RESOLVED | |
| 40 | RESOLVED | |
| 41 | UNRESOLVED | DCG/QUE/41/4 |
| 42 | RESOLVED | |
| 43 | UNRESOLVED | SCP/RBN/QUE/1 |
| 44 | UNRESOLVED | SCP/RBN/QUE/2 |
| 45 | RESOLVED | |
| 46 | UNRESOLVED | SCP/NAE/COM/4 |
| 47 | UNRESOLVED | TM/COM/3 |
| 48 | RESOLVED | |
| 49 | UNRESOLVED | DCG/COM/49/4 |
| 50 | RESOLVED | |
| 51 | UNRESOLVED | DCG/QUES/51N/4 |
| 52 | UNRESOLVED | SCP/NAE/COM/21 |

TOTALS

| | |
|------------|-----|
| RESOLVED | 105 |
| UNRESOLVED | 62 |

TABLE 2

SCP CONCERNS BY SPECIFIC PROGRAM

| <u>Program</u> | <u>Objections</u> | <u>Comments</u> | <u>Questions</u> |
|--|-------------------|-----------------|------------------|
| Issue Resolution Process & Approach (8.0-8.2) | | 5 | 0 |
| Planned Tests, Analyses, & Studies (8.3) | | 2 | 0 |
| Site Program (8.3.1) | | 0 | 0 |
| Overview (8.3.1.1) | | 2 | 0 |
| Geohydrology (8.3.1.2) | | 13 | 1 |
| Geochemistry (8.3.1.3) | | 9 | 0 |
| Rock Characteristics (8.3.1.4) | | 10 | 10 |
| Climate (8.3.1.5) | | 0 | 0 |
| Erosion (8.3.1.6) | | 2 | 0 |
| Rock Dissolution (8.3.1.7) | | 0 | 0 |
| Postclosure Tectonics (8.3.1.8) | | 9 | 2 |
| Human Interference (8.3.1.9) | | 1 | 2 |
| Population Density & Distribution (8.3.1.10) | | 0 | 0 |
| Land Ownership & Mineral Rights (8.3.1.11) | | 0 | 0 |
| Meteorology (8.3.1.12) | | 0 | 0 |
| Offsite Installation & Operations (8.3.1.13) | | 0 | 1 |
| Surface Characteristics (8.3.1.14) | | 0 | 0 |
| Thermal & Mechanical Rock Properties (8.3.1.15) | | 4 | 2 |
| Preclosure Hydrology (8.3.1.16) | | 0 | 0 |
| Preclosure Tectonics (8.3.1.17) | | 12 | 1 |
| Repository Program (8.3.2) | | 2 | 4 |
| Seals Program (8.3.3) | | 3 | 6 |
| Waste Package Program (8.3.4) | | 1 | 11 |
| Performance Assessment Program (8.3.5) | | | |
| Preclosure (8.3.5.1-.7) | | 3 | 5 |
| Postclosure (8.3.5.8-8.3.5.20) | | 42 | 9 |
| Exploratory Shaft Impacts (8.4) | 1 | 4 | 8 |
| Schedules (8.5) | 0 | 0 | 0 |
| Quality Assurance (8.6) | 1 | 2 | 0 |
| DAA | 0 | 7 | 1 |

TOTALS

2 Objections
133 Comments
63 Questions