

COMM ASSIST MEMO

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NOTE TO: Commissioner Technical Assistants

FROM: James L. Blaha
Assistant for Operations, EDO

SUBJECT: BACKGROUND INFORMATION FOR THE STATE OF NEVADA COMMISSION
BRIEFING ON DECEMBER 1, 1988

Enclosed for your use is background information and possible questions related to the December 1, 1988 briefing of the Commission by the State of Nevada. These were prepared by Division of High-Level Waste Management in coordination with OGC, GPA, and ACNW staff.

Copies of the 2 volumes of State comments on DOE's Consultation Draft Site Characterization Plan are available from King Stablein (x20446) if you desire. If you require any additional assistance, please contact Joe Holonich on x23403.

Original signed by
James L. Blaha

James L. Blaha
Assistant for Operations, EDO

Enclosure:
As stated

cc: S. Treby, OGC
R. Virgilio, GPA
J. Guttman, SECY

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Background Information and Possible Questions
Related to the Briefing by the State of Nevada
December 1, 1988

1. NRC staff interface with the State of Nevada's HLW repository oversight program was discussed in SECY-88-221. As noted in SECY-88-221, the major NRC action was to review and comment on the State's QA Manual. In this regard, the State submitted its proposed quality assurance procedures to NRC for review on June 28, 1988.

NRC staff has completed its review and by letter dated November 25, 1988 has provided comments to Nevada which will require resolution prior to NRC's acceptance of the State's quality assurance manual.

2. The State has provided comments to DOE on DOE's CDSCP. The State comments were dated September 6, 1988. DOE has taken the position that the State comments were received too late to be considered in DOE's final SCP currently scheduled for issuance in December 1988. DOE has indicated that changes necessary to resolve Nevada comments would be addressed in subsequent six-month updates of the SCP.

The State comments are included in two volumes, each approximately an inch thick. Attached for convenience is the State forwarding letter and the overview section of the State comments. On page 4 of the State forwarding letter, it is noted that "Finally the State of Nevada has reviewed the NRC comments on the CDSCP and find agreement with all of the issues which NRC has raised including the need for DOE to have a fully qualified quality assurance program in place prior to finalizing the design or initiation of the excavation of exploratory shafts." Although this is a direct quote from the State of Nevada it should be noted that the NRC staff comment stated that DOE needs to have a qualified QA program prior to the start of new site characterization.

It should be noted that the Commission has previously taken the position that the State of Nevada should take its concerns directly to DOE and that the DOE is responsible for resolving applicable State concerns. Thus, NRC staff should not be placed in the position of commenting on Nevada comments to DOE prior to and independent of DOE's responding directly to Nevada.

The NRC staff has skimmed the State of Nevada comments to ensure they are generally familiar with the areas of State concern. Based on this broad and quick review, the staff sees no technical issues that would require NRC making any additional comments to DOE. It would appear that DOE's attempts to resolve NRC's comments on DOE's CDSCP should address, if not resolve, the State of Nevada's concerns.

3. The Advisory Committee on Nuclear Waste has been in contact with the State of Nevada and decided not to review the State's comments on the SCP until a later date. This decision was based on the DOE position that changes necessary to resolve the State's comments will be addressed in six-month updates of the SCP.
4. The State of Nevada has been observing DOE audits of their prime contractors along with the NRC staff. The NRC staff prepares formal reports documenting concerns with the audits and expects DOE to address these concerns in future audits.

The State has furnished comments on several of the audits to the staff and no new concerns were identified by the State. The staff will review State comments on all of the audits prior to agreeing that the DOE QA program is acceptable.

Possible questions the Commission may want to ask the State of Nevada representatives are as follows:

1. How is the relationship between NRC and the State of Nevada working?
2. Are there any areas of major technical disagreement between the NRC staff and the State of Nevada technical personnel?
3. Does the State have any comments on the benefit of the Licensing Support System?
4. What is the State of Nevada doing to ensure the documents generated by the State and its contractors can be readily introduced into the proposed Licensing Support System?
5. When will the States be ready to start providing documents to the Licensing Support System?
6. Does the State have any suggestions for improving the interface between NRC and State technical experts during the prelicensing consultation phase?
7. What comments do you have on the recent GAO report on repository Quality Assurance?
8. DOE has had difficulty in having Quality Assurance accepted by some of its contractors, particularly some of the geoscientists. What kinds of experiences have you had in implementing your Quality Assurance program with the State's technical contractors?
9. How are the views of Local Affected Governments and Indian Tribes being factored into the State's high-level waste program activities?



**AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE**

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September 6, 1988

C.E. Kay, Acting Director
Office of Civilian Radioactive
Waste Management
U.S. Department of Energy
1000 Independence Ave.
Washington, D.C. 20585

Dear Mr. Kay:

The State of Nevada has completed its review of the Consultation Draft - Site Characterization Plan (CD-SCP) for Yucca Mountain issued by the Office of Civilian Radioactive Waste Management (OCRWM) of the U.S. Department of Energy (DOE) in January. This document (Volumes 1 & 2) contains our comments for your review and consideration. We are pleased to have the opportunity to provide such comments on the CD-SCP and hope that you find them constructive and useful as you prepare the statutory Site Characterization Plan as required by Sec. 113 of the Nuclear Waste Policy Act (NWPA).

As you are aware, Sec. 113 (b)(1) of the NWPA requires the Secretary of Energy to submit to the Nuclear Regulatory Commission and the State of Nevada for review and comment:

- A. a general plan for site characterization activities to be conducted at such candidate site, which plan shall include -
- i) a description of such candidate site.
 - ii) a description of such site characterization activities...
 - iii) plans for the decontamination and decommissioning of such candidate site...

- iv) criteria to be used to determine the suitability of such candidate site...; and,
 - v) any other information required by the Commission
- B. a description of the possible waste form or packaging for the high-level radioactive waste and spent nuclear fuel...; and,
- C. a conceptual repository design that takes into account likely site specific requirements.

Considering the NWPA requirements for the content of a Site Characterization Plan, we find the CD-SCP to be statutorily deficient. In general, the description of site characterization activities is inadequate and incomplete, plans for decontamination and decommissioning absent, description of the possible waste form or package is nonexistent and the document does not contain a conceptual repository design.

The NWPA contains several other requirements regarding the issuance of the Site Characterization Plan and the initiation of site characterization activities. Sec 113(a) requires that the Secretary shall consider fully the comments received on the statutory SCP and shall conduct site characterization activities in a manner that minimizes any significant adverse environmental impacts identified in such comments. Sec. 113(b)(2) requires that before proceeding to sink shafts at any candidate site, the Secretary shall (A) make available to the public the statutory Site Characterization Plan, and (B) hold public hearings in the vicinity of such candidate site to inform the residents of the area, and to receive their comments.

The CD-SCP is not the statutory SCP required in Sec. 113 of the NWPA, and contains no discussion of environmental impacts. Further, the CD-SCP has not been released for public comment nor have public hearings been conducted.

Based upon the foregoing review of Sec. 113 regarding the Site Characterization Plan, it is clear that Congress intended that the Department of Energy not engage in any site characterization activities, including preparation to proceed to sink shafts until the statutory SCP has been released, public hearings conducted, and the public's and others' comments received and fully considered by the Secretary of Energy. Only then can DOE begin site characterization activities.

In August of 1987, when DOE initially announced plans for the release of a "consultive draft SCP for Yucca Mountain", the State of Nevada and the DOE reached agreement on several issues related to the State's review of the CD-SCP. First, Nevada initiated and requested a series of technical workshops on

issues. In addition, the State requested that the CD-SCP be a comprehensive, complete document containing study plans, the environmental program plan, environmental field activity plans, and environmental and socioeconomic monitoring and mitigation plans.

Despite a firm commitment from DOE that the CD-SCP would be a comprehensive document containing or accompanied by all of the aforementioned plans, DOE released the CD-SCP on January 8, 1988 without these plans, with the exception of the draft environmental and socioeconomic monitoring and mitigation plans. As of the writing of these comments, these plans have yet to be released. This makes a thorough review of the site characterization program impossible.

Without a reasonably complete set of detailed study plans and environmental program plans, it is impossible to adequately oversee and review DOE's proposed program for characterization of the Yucca Mountain Site. It is also impossible to adequately assess the complete impact of site characterization on the citizens and the environs of the State of Nevada. Therefore, the enclosed comments must be considered preliminary given the inadequacy of the current SCP document.

We believe the DOE's approach to site characterization should be reexamined and the SCP significantly revised before it can be viewed as a credible basis for evaluating the suitability of Yucca Mountain to host a repository. The purpose of site characterization is to develop sufficient information to support a determination of the suitability, or lack of suitability of the site to safely isolate high-level radioactive waste with reasonable certainty for thousands of years. It should come as no surprise that Nevada's expectations in this endeavor are that any repository site determined to be suitable must, first, be the best understood piece of geology on earth. To meet this requirement, nothing less than the most rigorous objective scientific research and investigation will be acceptable. If the site proves too complex to meet this goal, or if its natural waste isolation capabilities will be compromised by the techniques necessary for collection of subsurface information or the construction of underground facilities, this should be determined as rapidly and efficiently as possible in order to avoid wasting billions of dollars and a number of years in fruitless pursuit of a national nuclear waste repository at Yucca Mountain. The document as written fails to ask crucial site suitability questions, lacks the specificity required for an adequate and meaningful review, and, most importantly, attempts to cloud and obscure technical issues and divert attention from potentially disqualifying flaws.

Perhaps the most fundamental shortcoming of the CD-SCP is the implicit assumption that Yucca Mountain is, in fact, suitable for development as a repository. The CD-SCP reflects no focused, credible effort to examine, at any time during the site characterization program, potential disqualifying conditions which are well recognized to exist at the site. A major decision point must be established within the statutory SCP, to determine whether site characterization should continue or not. A "go no-go" determination should be made early in the site characterization program consistent with recommendations made to the DOE in 1979 about the Yucca Mountain site by the National Academy of Sciences.

In order to arrive at the expected and required level of knowledge and understanding of the site, the DOE's plan must take into account, in the most scientifically objective and rigorous manner, the complexity of the site and setting and the fact that the available data can lead to various interpretations of the geologic history and dynamics of the system of which Yucca Mountain is a part. It is only through a very carefully planned and comprehensive data collection effort, allowing for the emergence of a spectrum of alternative interpretations, that the future dynamics and effects of the system can be reasonably predicted and serve as the basis of a license application to the NRC. It is not the initial purpose of site characterization to simply seek to collect sufficient data to support a preconceived site suitability or repository design notion. The geologic barrier system and all geologic processes that affect it must be fully defined. If the competence of this primary barrier is judged suitable for long-term waste isolation, the design options and their effects on waste isolation can subsequently be evaluated. The enclosed comments demonstrate that serious flaws exist with the CD-SCP and with the DOE's entire approach to site characterization.

Our review of the CD-SCP suggests that (1) the Department of Energy has failed to recognize the complexity of the site; (2) the Department of Energy has made a determination that careful characterization is not necessary, nor perhaps desirable; and (3) the Department of Energy has failed to effectively develop and manage the required scientific program to confidently select and characterize the site. I urge you to re-examine the SCP and the Department's entire site characterization program.

Finally, the State of Nevada has reviewed the Nuclear Regulatory Commission's comments on the CD-SCP and find agreement with all of the issues which NRC has raised, including the need for DOE to have a fully qualified Quality Assurance Program in place prior to finalizing the design or initiation of the excavation of the exploratory shafts.

I trust that our comments will be taken in the constructive manner in which they are presented. My staff stands ready to meet with representatives of the Department of Energy to discuss our comments. I look forward to your response.

Sincerely,

A handwritten signature in black ink, appearing to read "Robert R. Loux". The signature is fluid and cursive, with a large, sweeping flourish at the end.

Robert R. Loux
Executive Director

RRL:CAJ:ed

PART I

OVERVIEW

THE BASIC APPROACH OF THE CD-SCP DOES NOT COMPLY WITH NWPA DIRECTIVE AND INTENT.

In its fundamental approach, the CD-SCP can more accurately be described as a licensing document, rather than a plan for characterizing the site, for determining its suitability in the first instance as the location for a repository. The CD-SCP, and indeed the entire site characterization program, consists of a strategy to uncover the information necessary to license, design and operate a repository at Yucca Mountain, rather than to determine whether the natural geology and hydrology of the site and its immediate environs will provide the necessary waste isolation.

The Preface itself is enlightening in this respect. In discussing the process of consultation the draft says:

"The DOE believes that the benefits of the consultation process would be maximized if the interactions focused on several key questions. For the NRC staff the key question is as follows: does the SCP-CD provide confidence that the DOE has adequately identified the issues and the kinds of information the NRC will need in its licensing decisions? The key question for the states and the affected indian tribes is how well the specific concerns have been identified and addressed." (Emphasis supplied) Vol. I, page clvi.

Nowhere does it say that a key issue for anybody is whether or not the Yucca Mountain site is suitable, or whether or not it is capable of isolating the nuclear waste. The Preface goes on to state, at page clvii:

"The purpose of preparing such a comprehensive and detailed plan is to facilitate the review of the planned site characterization program by the states and affected indian tribes [and] (sic.) to obtain from the NRC staff input as to whether the program covered by the plan can be expected to be sufficient for eventual licensing." (Emphasis supplied).

Many of the detailed sections of the CD-SCP set out a program designed to gather the data necessary to design a repository that will attempt to comply with the applicable standards and regulations, not to determine whether one should be located at this site in the first place. This is evident from the outset. For example, in par. 1.0.3 the draft says:

"Tectonic data collected to date are insufficient for a full assessment of earthquake and volcanic hazards at Yucca Mountain. A key uncertainty is the location, length, and slip rates of Quaternary faults at and near Yucca Mountain. This uncertainty impedes reliable estimates of the magnitude, recurrence intervals, and ground motion from future earthquakes that are to be considered in the design and performance of the repository." (Emphasis supplied).

This is but one example of what seems to be a pervasive defect in the CD-SCP, and in the entire site characterization program.

Furthermore, the CD-SCP again ignores what should be a fundamental aspect of any objective, well conceived and well managed site characterization program: to structure the program to determine, as early as possible, whether any conditions which would disqualify the site from further consideration exist. While the CD-SCP discusses the need to determine if such condition exists, an evaluation of such findings will apparently be made only at the conclusion of the entire program. No mechanism exists, no key decision points are set out, to uncover the data necessary to make such decisions early in the program, before substantial, and perhaps unnecessary, resources are committed.

This is not a new concern. The State and the NRC have been consistent in making such a recommendation for some time. Those recommendations have, just as consistently, been ignored. In 1979 the Committee on Radioactive Waste Management of the National Academy of Sciences also urged the DOE to structure its program in this way. The Committee suggested "...that the explorations and investigations be conducted in a logical sequence so as to assure that certain fundamental questions be addressed first before major resources are committed."

Those fundamental questions remain unanswered. The State again urges the DOE to structure its entire site characterization program to diligently search for disqualifying information first, through an adequate surface-based testing program, before any further resources are committed to the exploratory shaft and, perhaps unneeded, underground testing program.

The DOE's fundamental approach is misguided for another reason as well. The SCP should not be finalized, and site characterization should not begin, until final comprehensive EPA standards are in place. Perhaps the best support for this position is the language of the CD-SCP itself.

In section 8.1.1.1 the draft sets out and discusses the issues hierarchy, saying:

"On the first, or highest tier there are four key issues, which embody the principal requirements established by the regulations governing geologic disposal. . . . The issues hierarchy, then, defines issues that must be resolved to demonstrate compliance with key regulatory requirements".

That section goes on to say:

"Key Issue 1 (post-closure performance) is derived directly from the post-closure system guideline (10 C.F.R. 960.1-4), which defines the general long-term performance requirements for the disposal system as a whole. These performance requirements reflect the general objectives of protecting the health and safety of the public and the quality of the environment; they are based specifically on the standards promulgated by the Environmental Protection Agency (EPA) in subpart B of 40 C.F.R. Part 191 (EPA, 1985)."

Key Issue 2 (preclosure radiological safety) is derived from preclosure system guidelines (10 C.F.R. 960.1-5-1(a)(1)). It requires compliance with the applicable requirements of the EPA standards in subpart A of 40 C.F.R. Part 191." (Emphasis supplied).

In discussing the issues, within the issues hierarchy, the draft, on page 8.1-3, says:

"The issues are derived, in part, from the DOE citing guidelines in 10 C.F.R. part 960, from the NRC performance objectives and design criteria of 10 C.F.R. Part 60, and from the EPA requirements of 40 C.F.R. Part 191".

As is now known much, if not all, of the "existing data" which form Chapters 1 through 7 of the draft is unusable because it cannot be qualified under NRC quality assurance requirements. This is true of all the DOE generated "data" reported in Chapters 1 - 7, which form the foundation for the entire site characterization program outlined in Chapter 8. At a minimum a thorough, comprehensive and objective review of all of that information should be conducted. Any "existing data" which cannot clearly meet QA requirements should be discarded, Chapters 1 - 7 revised, and Chapter 8 rewritten to encompass studies designed to provide a comprehensive data base which meets all QA requirements.

The entire underlying framework for the CD-SCP which is hinged upon the presumption that indeed the Yucca Mountain site is suitable for development as a repository is not only wrong but demonstrates the lack of scientific process and methods which has permeated this program since 1979. Additionally, the CD-SCP does not comply with the intent of Sec. 112 and 113 of the Nuclear

Waste Policy Act. As has been well documented, the Department of Energy has in nearly every instance since the program began made concrete programmatic decisions without any scientific or technical data. Only after these decisions have been made, does the Department collect data, and then only data that support DOE's predetermined view of the site. The CD-SCP is a continuation of this process, where the assumption that Yucca Mountain is suitable has already been made in the absence of any credible scientific data. The site characterization program as laid out in the CD-SCP is an exercise to only collect data that support DOE's predetermined view of Yucca Mountain while a subsurface and surface facility is being designed.

This type of pre-judged decision making without supporting data has been the subject of criticism of the program since the beginning by all parties and suggests that very little, if any, portion of the program is based in credible science or technical merit. The fact that DOE has, in essence, determined that Yucca Mountain is suitable in the absence of the EPA standards, which the site must meet, is a further example of the lack of any meaningful scientific processes or method.

LACK OF ALTERNATIVE CONCEPTUAL MODELS CONSIDERATION INVALIDATES THE CD-SCP.

Since release of the CD-SCP, there has been considerable comment and discussion on the matter of the document failing to consider a range of alternative conceptual models (working hypotheses) of the Yucca Mountain site geology and geohydrologic setting. Furthermore, it does not establish a site testing program that would lead to an evaluation of alternative conceptual models that could be consistent with site data, were such an objective included in the CD-SCP.

The NRC, USGS (Headquarters), State of Nevada, and Nevada geotechnical contractors have reviewed, commented upon, and discussed this matter with the DOE, and appear to be in general agreement with the conclusion that the CD-SCP is deficient in that the plan does not provide a basis, from site testing, for predictive performance assessment where uncertainty exists, as required by the NRC's 10 CFR 60. The CD-SCP appears to have adopted, and seeks to defend a single, simplified model of the site that largely ignores the need for thorough investigation of a range of coupled geologic and hydrologic processes and events and their potential significance to waste isolation.

In order to resolve this major deficiency in the CD-SCP, extensive and integrated revision is necessary to incorporate an appropriate range and sequence of testing necessary for determining site suitability for waste isolation and support a license application.

DOE'S "REASONABLY AVAILABLE TECHNOLOGY" CONSTRAINTS HAVE NOT BEEN MET.

The CD-SCP describes in general terms a large number of activities which will require the use of testing and analytical equipment and methods in order to collect the requisite data, yet there is no substantive review of the availability of state-of-the-art technology to perform the tests in a valid and verifiable manner. The Site Characterization Program is constrained to the use of "reasonably available technology", which is defined in DOE's Final Siting Guidelines (10 CFR Part 960) as "technology which exists and has been demonstrated or for which the results of any requisite development, demonstration, or confirmatory testing efforts before application will be available within the required time period."

In addition to site characterization and exploratory shaft facility construction activities being constrained to the use of "reasonably available technology", repository construction, operation and closure are similarly constrained in the application of certain engineered barriers potentially necessary to enhance the natural geologic barrier system (eg. Rock Characteristics, 960.5-2-9(d); Hydrology, 960.5-2-10(d); Tectonics, 960.5-2-11(d)).

A notable example of a general field of technology necessary for site characterization in which there is considerable concern about the ability of available technology to provide needed data from the Yucca Mountain site is geophysical exploration. Efforts to acquire certain necessary data from depth at Yucca Mountain, using available seismic reflection techniques, have provided no useful results, and it is likely that further, possibly extensive research and development in geophysical techniques will be necessary in order to resolve subsurface issues in the Yucca Mountain setting. This concern regarding geophysical techniques is further evaluated in NRC NUREG/CR-4957 (July 1987): Survey of Geophysical Techniques for Site Characterization in Basalt, Salt and Tuff.

The CD-SCP does not provide specific information on how this matter is to be resolved, nor does it acknowledge that 1.) new techniques that may be developed would likely require, for purposes of validation and verification, core and borehole data from the repository block, resulting in additional boreholes that may adversely affect waste isolation (a concern expressed in NRC's 10 CFR 60.15(d)); 2.) if it is determined that existing or newly developed geophysical techniques cannot provide valid data needed for licensing, an alternative might be to drill and core a large number of boreholes in and around the site to acquire the needed stratigraphic, structural and other data (although this, too, may be unacceptable in view of 10 CFR 60.15(d)).

Other examples of fields in which reasonably available technology likely will not provide the necessary valid data for a license application at the Yucca Mountain site are comprehensive borehole logging and collection of fluids from boreholes in the unsaturated zone. Again, a program of research and development, validation and verification will probably be necessary in advance of collection of valid data from the Yucca Mountain site, yet specific recognition of this need and plans for such activities are not included in the CD-SCP.

SYNOPSIS OF SPECIFIC COMMENTS

LICENSING

Site specific issues and their relative importance to waste isolation, are not clearly addressed. The NRC Regulatory Guide 4.17 (Rev. 1, March 1987) clearly states: "The basic purpose of the SCP is simple: to provide a mechanism for identifying and delimiting the specific issues at a proposed repository site and to identify the plans for resolving those issues at an early time in order to avoid delays in the process." The CD-SCP provides for neither of these requirements.

The CD-SCP represents a primarily generic and generalized approach that does not recognize a full range of issues specific to the Yucca Mountain site that must be resolved.

The schedule is ambiguous and vague. Much of the critical information (e.g. design earthquake, matrix vs fracture flow beneath the repository, amount of offset to be expected in the repository, etc.) will not be available until the License Application Design (LAD) is almost completed (Fig. 8.5-3, p. 8.5-80A; Fig. 8.5-4, p. 8.5-86).

GEOLOGY

Chapter 1, which is to summarize what is known about the site from DOE exploration activities completed to date, is invalid and out-of-date and does not represent a data base often referred to in chapter 8.

The regional study of active faults is inadequate. There appears to be a general reluctance to incorporate information from a regional base unless it can be shown that something (be it a fault or volcanic feature) may have a direct consequence on the repository or on surface facilities. For example, active faults within 100 km, but not within the site, are only to be studied if a cursory examination shows that they could sustain an earthquake event large enough to cause significant ground acceleration. This approach will not yield a true picture of the temporal and spatial history of seismicity.

The concept and use of the 10,000 year cumulative slip earthquake is unacceptable. This type of seismic source characterization is unconventional, unrealistic, misleading, and non-conservative. First the CD-SCP states that the 10,000 year event "can be determined with greater confidence than a true maximum magnitude." This may be incorrect, because additional input parameters and uncertainties are involved in the estimation of the 10,000 year event as compared to the maximum earthquake estimate. Second, the CD-SCP argues that "low slip-rates suggest that the use of fault length or displacement to develop deterministic estimates of magnitude for a given fault are misleading." The analysis of faults with low slip rates (or longer recurrence intervals) may incur larger uncertainties but this does not render the analysis meaningless or "misleading". Third the CD-SCP states that, "Use of slip-rate data (to constrain recurrence times) in conjunction with more conventional fault data provides added assurance that adequately conservative assessment of the local seismogenic potential will be accomplished". This is a fuzzy statement which appears to imply, incorrectly, that the use of a maximum earthquakes is overly conservative in most local source scenarios since the duration of "cumulative slip" of these events would be longer than 10,000 years.

There are two additional reasons for not considering the 10,000 year event as conservative. First, the 10,000 year event estimation is completely dependent on long-term averages. Recent work, however, has shown that fault activity in the Basin and Range Province and other regions commonly exhibit spatial and temporal clustering events. Averages and recurrence intervals over short-term periods can be greatly different than those over the long term. Second, considering historical earthquakes in Nevada that have involved several faults rather than a single fault, a seismic source estimation of a single fault may actually underestimate potential seismic hazards.

A primary flaw of the CD-SCP is the failure to adequately incorporate coupled-process considerations. For example, all disruptive scenarios involving faulting consider the possibility of rupture along only a single fault. The possibility of complex events, with distributed rupture on multiple faults is not considered, even though existing evidence indicates this may have occurred in the past. Evidence from Yucca Mountain (basaltic ash in fault fractures and close spacing [< 2 km] of surface faults) suggests an intimate interrelationship between the surface faults and emplacement structures of the Crater Flat basalts/Lathrop Wells Cone. A second example is the inadequate application of standard hydrologic models. Little is known about the boundary conditions of the zone of saturated flow, and no studies have been planned to address this problem. This deficiency has already been noted by Szymanski in his study of the ground water system of the Death Valley region. Earth scientists are

accustomed to the idea that any set of rocks is an integrated result of physical, chemical, and biological interactions during and after the original formation of the rocks. For practical reasons, a simplified approach must be used initially in the study of such complex systems, but it must always be kept in mind that the applications of simplified models to concrete crustal problems may or may not be reasonable, and that more sophisticated interpretations generally are developed as data bases become more complete and comprehensive.

NATURAL RESOURCES

The "evaluation" of mineral and hydrocarbon resource potential given in sections 1.7 and 1.8 is built on incomplete, outdated, often inaccurate and misleading information and is wholly inadequate.

The proposed characterization program is inadequate to evaluate the resource base in and near Yucca Mountain and thus will not provide data which will assure a minimum likelihood of future human interference. Future studies must include several boreholes within the site boundary and adjacent to it, and these must not only penetrate the Tertiary section, but also provide samples from a representative section of the underlying Paleozoic rocks. Several boreholes must also directly test faults, intersections of faults, breccia zones and highly fractured zones for evidence of hydrothermal mineralization. The hydrocarbon and geothermal potential will also remain untested without deep drilling in the controlled area or the repository block.

ROCK MECHANICS

The rock mass characterization plan is based on measurements made on small samples, both in the lab and in-situ, and the use of these measurements to extrapolate to the larger scale, using numerical programs. These extrapolations include the use of estimates of joint and fault behavior. This technique has not been validated for the large type of structure being studied. The effect of larger fractures, joints, and especially faults, both in and near the repository on the overall behavior of the repository is not adequately described.

GEOCHEMISTRY

There appears to be no comprehensive synthesis of the information available on the ground-water chemistry. The chemical analyses are not integrated with the hydrologic and geologic information. Synthesis of all such data is necessary to make the greatest use of hydrochemical information for planning purposes.

The details of analytical methodologies and technical procedures is often inadequate. There is a lack of detail about the needed collection of representative water samples from different tuff strata. More detail is necessary on the effect of filter size, the redox potential, and analytical quality for proper assessment of the applicability of the data. Many of the tests appear to be prototypes and do not directly address site-specific data needs. Undue emphasis is placed on modeling before experimental methodologies are proven and meaningful field data are collected.

Most of the credit taken by the DOE for ground-water travel time derives from the vadose zone and therefore assumes most of the retardation would also occur in the vadose zone. Obtaining chemical analyses of a vadose-zone water should be of the highest priority and the range of vadose-water composition should be determined as quickly as possible.

Not enough importance is being attached to determining the validity of extrapolating from laboratory sorption data to actual field conditions. It is extremely difficult to envision how data from experiments employing crushed tuff could be correlated to the field with any scientifically valid confidence. Highest priority should be assigned to validating the proposed experimental approach through field tests of sorption or retardation before additional resources are expended in this extensively practiced but totally unproven methodology.

As is the case for the topics of geology and hydrology, the evaluation of individual geochemical scenarios for the purpose of eliminating those with insignificant consequences may overlook the coupling that can occur between two or more processes/events producing significant consequences for predicting release of radionuclides to the accessible environment. It appears that this has occurred, i.e. the DOE has omitted the most obvious scenario of water vapor driven from the thermal envelope condensing in the cooler fractures that surround the repository horizon and returning to the boiling zone by gravitational forces.

HYDROLOGY

The DOE's conceptual model incorrectly emphasizes vertical recharge through the top of Yucca Mountain. Recharge is assumed to be uniformly distributed throughout the proposed boundary area of the repository. Also, recharge is assumed to be uniform in time. As a result, there are no plans directly related to assessing the recharge potential of the many ephemeral streams which drain to the east and north off of the site. In desert terrain such as the Yucca Mountain site, the recharge may be low and variable. However, much of the recharge is certainly

concentrated and focused beneath washes, in and through open and exposed fractures, and through faults in the rock matrix of the repository block.

The factors which control ground-water levels near Yucca Mountain are not well known. North and west of the repository area, hydraulic gradients are uncharacteristically high. Beneath and east of the repository area the hydraulic gradient is very low. The reasons for the high gradients are unknown. One effort is planned that may provide an explanation of the gradient in the west. No testing is planned to study the gradient in the north, which is greater than the gradient in the west.

The current conceptual model for flow of water through the unsaturated zone is not based on nor supported by available data. The model assumes that matrix flow predominates over fracture flow in the unsaturated zone and that the matrix must be saturated for fracture flow to occur. No data exist to support these assumptions for any formation and especially for the Calico Hills formation which in the DOE's conceptual model is one of the most important barriers to the release of radionuclides to the environment. In fact, based on the very limited and questionable suction-head data available from well UZ-1 for the various rock units, these tuff units are most likely effectively saturated and therefore fracture flow should be predominant. The adopted estimate of the vertical ground-water flux for performance assessment studies is inconsistent with the recharge flux information available from published data.

The methodologies proposed for obtaining in-situ data on moisture conditions in the unsaturated zone are based on porous media models which are inappropriate for fractured tuff. The methodologies are highly experimental, and have questionable probability of success.

Air and water vapor migration in the unsaturated zone is not adequately addressed. These processes may lead to the discharge of radionuclides to the immediate surface environment. The CD-SCP deals entirely with travel time from the repository to the saturated ground-water system, and ignores this other likely process. The possibility of upward vapor migration has been suggested in Montazer and Wilson (1984), but no research is proposed to study the impacts of such processes on gaseous radionuclide migration.

The process of dispersion in partially-saturated, fractured tuff has not been addressed in the scientific literature beyond the theoretical stage. The dispersion process, while reducing maximum concentration will also decrease the time of first arrival at the accessible environment. The impact of dispersion will therefore reduce the travel time when compared with bulk

ground-water travel-times. Studies should be conducted to study the dispersion process in the unsaturated fractured tuffs of Yucca Mountain to determine if theoretical studies completed to date agree with the field results. Additional work will also be needed in model development of transport in both saturated and partially-saturated, fractured tuff.

The CD-SCP places emphasis on the disturbed zone as that zone where intrinsic permeability and effective porosity are altered. For an unsaturated-zone repository such factors are not relevant. Disturbed-zone criteria should be based upon alteration of the relative permeability curves (analogous to intrinsic permeability) and water retention (analogous to effective porosity). These parameters will control fluid, air, and radionuclide transport near the repository and will contribute to a coherent picture of the affects of disturbance.

The studies of the saturated zone rely too heavily on previous, and questionable, aquifer tests which were analyzed using a porous media model that assumes homogeneity, isotropy, and radial flow. The model is inappropriate for use in interpreting most of the tests because steeply dipping fractures control the movement of water into and out of the boreholes. The inappropriateness of the model is demonstrated further by poor agreement between the type curves and the current data set. No attempt has been made to develop or apply models that produce good agreement between the aquifer test data and the type curves.

The two dimensional, plan view conceptual model is inadequate to explain the flow system in the saturated zone. The areal pattern of hydraulic heads suggests the existence of narrow ground-water barriers across which large potential gradients occur, combined with larger regions of very small gradients. Additionally, areal variation of the location of the water table within each of these zones probably depends on relationships with deeper aquifers as well as on horizontal flow. A three dimensional model is essential.

SEAL PROGRAM

The program is mostly based on the report of Fernandez, et. al. (1987) which fails to include a cumulative release formula in the analysis of radionuclide releases from failed canisters.

PERFORMANCE ASSESSMENT

The three sections on higher level findings, 8.3.5.6- preclosure radiological safety, 8.3.5.7 - ease and cost of construction, and 8.3.5.18 - postclosure system and technical guidelines, lack time schedules that indicate decision points which would allow reevaluation of the site characterization process and possible redirection or termination of research.

At the beginning of Section 8.3.5.13 the assertion is made that a complementary cumulative distribution function (CCDF) will be evaluated, but in the ensuing analyses the emphasis is on the evaluation of the expected partial performance measure (EPPM). This section should be revised, and must conform with the NRC's outline for implementing performance assessment relative to total system performance.

The economic cost of retrievability, which is also classified as a performance issue in section 8.3.5.2, is not addressed in any of the SCP studies.