

JUN 24 1993

Mr. Dwight Shelor, Associate Director for  
 Systems and Compliance  
 Office of Civilian Radioactive Waste Management  
 U.S. Department of Energy, RW 30  
 Washington, DC 20585

Dear Mr. Shelor:

SUBJECT: REVIEW OF U.S. DEPARTMENT OF ENERGY (DOE) STUDY PLAN  
 "CHARACTERIZATION OF THE YUCCA MOUNTAIN QUATERNARY REGIONAL  
 HYDROLOGY," REVISION 2

On December 24, 1992, DOE transmitted Revision 2 of the study plan, "Characterization of the Yucca Mountain Quaternary Regional Hydrology" (Study Plan 8.3.1.5.2.1) to the U.S. Nuclear Regulatory Commission for review and comment. NRC has completed its review of this document using the Review Plan for NRC Staff Review of DOE Study Plans, Revision 1 (December 6, 1990). The material submitted in the study plan was considered to be consistent, to the extent possible at this time, with the NRC-DOE agreement on content of study plans made at the May 7-8, 1986, meeting on Level of Detail for Site Characterization Plans and Study Plans.

A major purpose of the staff's review is to identify concerns with studies, tests, or analyses that, if started, could cause significant and irreparable adverse effects on the site, the site characterization program, or the eventual usability of the data for licensing. Such concerns would constitute objections, as that term has been used in earlier NRC staff reviews of DOE's documents related to site characterization (Consultation Draft Site Characterization Plan and the Site Characterization Plan for the Yucca Mountain site). It does not appear that the conduct of the activities described in the revisions to this study plan will have adverse impacts on repository performance and the staff's review of this study plan identified no objections with any of the activities proposed.

As a result of its review of Revision 0 of this study plan, the staff provided DOE with three detailed technical comments and six questions to which DOE responded in a letter of December 19, 1990 (Desell to Linehan). The staff's evaluation of DOE's responses are enclosed. As a result of its evaluation of those responses, the staff concludes that one comment and five questions are resolved. The staff does not propose to provide any additional detailed technical comments or questions as a result of its review of Revision 2 of the study plan.

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Mr. Dwight E. Shelor

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If you have any questions concerning this letter, please contact Charlotte Abrams (301) 504-3403 of my staff.

Sincerely,

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Joseph J. Holonich, Director  
Repository Licensing and Quality Assurance  
Project Directorate  
Division of High-Level Waste Management  
Office of Nuclear Material Safety  
and Safeguards

Enclosure: As stated

- cc: R. Loux, State of Nevada
- T. J. Hickey, Nevada Legislative Committee
- C. Gertz, DOE/NV
- M. Murphy, Nye County, NV
- M. Baughman, Lincoln County, NV
- D. Bechtel, Clark County, NV
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## Enclosure

### **STUDY PLAN 8.3.1.5.2.1 - CHARACTERIZATION OF THE YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY**

#### Comment 1

Evidence to be considered for establishing paleowater table elevations appears to be restricted to near-surface calcite-silica veins.

#### Evaluation of DOE Response

The NRC staff recommended that the study should include an evaluation of subsurface evidence of paleowater table levels such as the characterization of available subsurface samples containing calcite and opaline-silica as well as other minerals that could be used to establish paleowater table elevations.

The DOE states that although the study is not restricted to characterizing near-surface calcite-silica veins for evidence of paleowater table elevations, the scope of the study does not explicitly include acquisition of core material from deep drillholes.

The DOE states that information about the deposition of minerals on faults and fractures obtained from drill core will be accomplished as part of Study 8.3.1.3.2.1 (Mineralogy, Petrology, and Chemistry of Transport Pathways) and Study 8.3.1.3.2.2 (History of Mineralogic and Geochemical Alteration of Yucca Mountain).

The DOE states that these studies are to provide data to evaluate the existence of paleowater tables by investigating the geochemical and isotopic composition of fracture-filling minerals.

The NRC staff has reviewed Study 8.3.1.3.2.1 which includes a section on the Role of Fractures and Faults as Past Transport Pathways and Evidence for Paleowater Table(s). Mineralogic, chemical, and petrologic clues will be used to suggest paleowater table elevations. The NRC staff has also reviewed Study 8.3.1.3.2.2 and found that one of the goals of that study is to use mineralogic and isotopic data to identify paleowater table elevation. Therefore, this comment is considered resolved.

**STUDY PLAN 8.3.1.5.2.1 - CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY**

**Comment 2**

Planned thermal scanner flight data may not provide sufficient areal coverage for the characterization of regional properties.

**Evaluation of DOE Response**

The NRC recommended that the DOE either justify the area covered by the thermal scanning or expand the area appropriate to a regional study.

The thermal scanning mission is a prototype-methods study to determine if this form of remote sensing can be used for characterizing hydrologic properties.

The thermal scanning mission is not meant to produce results applicable to the entire region to be examined by the past discharge activity.

If the prototype method works on a site-specific scale, application to a regional scale should be possible.

The specific test area was chosen so that the technique could be tested by researchers examining the unsaturated zone (Study Plan 8.3.1.2.2.3).

It has not been made clear whether the information from this prototype method is essential for characterization of the region; therefore, the NRC staff considers this comment open. DOE should report progress in developing this technique on a site specific scale and, if that proves successful, on a regional scale.

**STUDY PLAN 8.3.1.5.2.1 - CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY****Comment 3**

Although shallow opaline deposits, where organic factors have affected uranium distribution, will be compared with deeper opaline deposits to model uranium transport, characterization of organic material in spring and other water-precipitated deposits is not planned.

**Evaluation of DOE Response**

The NRC staff recommended that the activity should include the analysis of organic material in spring and other water-precipitated deposits.

The DOE responded by stating that reference to uranium mobility was intended to indicate that quantities of water needed to form the deposit as calculated from the quantity of opaline silica and standard inorganic chemical parameters might not produce a definitive result.

Furthermore, the DOE stated that by comparing deep and shallow opals, it can be demonstrated that organic matter can affect uranium distribution in opal.

The DOE response does not make clear the connection between the quantity of opal, the uranium distribution in opal, and the amount of water passing through the system.

The DOE response states that there is no intent in the study to address the detailed question of organic effects on mineral precipitation.

The main purpose of the comment, however, was to suggest that if organic factors can affect uranium distribution, these factors may also affect age determinations based on uranium-series disequilibrium method.

The DOE response did not address concerns with regard to age determination. Consequently, the NRC staff considers this comment open. The DOE should consider the potential effect of organic factors on age determination techniques.

**STUDY PLAN 8.3.1.5.2.1 - CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY  
REGIONAL HYDROLOGY**

**Question 1**

**Is the resolution of LANDSAT data adequate to provide the information needed in the study plan?**

**Evaluation of DOE Response**

**The NRC staff recommended that DOE should provide supporting evidence for this use of this technique.**

**The DOE states that the LANDSAT data are adequate for the stated purposes. The LANDSAT Thematic Mapper data were chosen for reconnaissance-level paleodischarge analysis.**

**The study plan states that site-specific studies will follow to provide final-scale resolution for areas of potential discharge.**

**The NRC staff considers this question resolved.**

**STUDY PLAN 8.3.1.5.2.1 - CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY**

**Question 2**

**Can electromagnetic conductivity be used to determine depth to the groundwater table as needed in this study plan?**

**Evaluation of DOE Response**

**The NRC staff recommended that the DOE provide evidence supporting use of this technique.**

**A particular instrument which measures electromagnetic ground conductivity is to be tested in the study area as a possible tool for locating shallow water tables or perched water and geologic structures.**

**This type of instrument is used in lieu of drilling to minimize surface disturbance.**

**The instrument will be tested at a site where depth to the water table is already known.**

**The NRC staff considers this question resolved.**

**STUDY PLAN 8.3.1.5.2.1 - CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY**

**Question 3**

What techniques will be used to determine the age of the ground water?

**Evaluation of DOE Response**

The NRC staff recommended that the DOE describe the groundwater dating techniques.

The DOE response states that groundwater dating will be done under the study plan, Characterization of Percolation in the Unsaturated Zone--surface based study.

Groundwater ages are to be calculated using the following radioisotopes; H-3, C-14, Cl-36, I-129, U-series, Ar-39, and Kr-85.

A review of Study Plan 8.3.1.2.2.3 (Study Plan for Characterization of Percolation in the Unsaturated Zone - surface-based study) has been conducted by the NRC staff (letter of March 26, 1992, from Holonich to Roberts). Groundwater dating is not described in that study plan. However, the NRC staff also reviewed Study Plans 8.3.1.2.2.7 (Hydrochemical Characterization of the Unsaturated Zone) and 8.3.1.2.3.2 (Characterization of the Yucca Mountain Saturated Zone Hydrochemistry) which describe groundwater dating techniques. Based on information provided in those two study plans, the NRC staff considers this question resolved.

**STUDY PLAN 8.3.1.5.2.1 - CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY**

**Question 4**

**How will the estimate of analog recharge be determined if the chloride ion mass balance and the water budget approaches do not agree well?**

**Evaluation of DOE Response**

**The NRC staff recommended that DOE provide a description of the steps that will be taken in the event the two models do not agree well.**

**The DOE responded by stating that if the chloride ion and water budget models do not agree, the choice between them will depend on the results obtained and perhaps an analysis of why the two results disagree.**

**It may be that the more conservative of the two results will be used.**

**Reference to a third model was made with the knowledge that U.S. Geological Survey research personnel from outside the YMP were trying to develop an alternative model.**

**The NRC recognizes that future directions of this activity depend upon the results of the currently planned tests. The staff considers this question resolved.**

**STUDY PLAN 8.3.1.5.2.1 - CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY  
REGIONAL HYDROLOGY**

**Question 5**

**What techniques will be used to characterize the silica deposits?**

**Evaluation of DOE Response**

The NRC staff recommended that the study plan should state which techniques will be used in characterizing geologic materials.

The DOE responded by stating that until all or at least some of the techniques have been tried to determine what techniques will provide the more useful results, the principal investigator cannot predict which, if any, techniques will not be used.

DOE's list includes the appropriate techniques. The NRC staff recognizes that some flexibility will be needed by project investigators when test results cannot be anticipated. Therefore, the NRC staff considers this question resolved.

**STUDY PLAN 8.3.1.5.2.1 - CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY****Question 6**

Will tracer isotopic compositions be determined for analog deposits and compared to those in Trench 14?

**Evaluation of DOE Response**

The NRC staff recommended that the DOE clarify whether isotopic compositions of analog deposits will be determined.

The DOE responded by stating that "tracer isotopes will not generally be used on the analog deposits because the results are not directly related to the Trench 14 problem."

Although tracer isotopes such as strontium reflect the history of the depositing fluid, the reflection is only a picture of the local geology through which the fluid passed.

The DOE response states that "For example, the strontium in an analog deposit may reflect isotopic equilibrium with a particular formation at great depth, an identical isotopic composition for a deposit of unknown origin need not lead to the same conclusion because the information from which the analog deposit derived its isotopic signature may not occur anywhere near the deposit of unknown origin."

The NRC staff considers that tracer isotopes can be used to establish the analogous character of the analog deposits. For example, Marshall and others (1991) use strontium isotopic ratios to suggest origins of carbonate deposits. Likewise, Stuckless (1991) uses the strontium isotopic ratios in vein calcite from Devils Hole to suggest the isotopic composition of groundwater in the system has remained constant for the past 600 ka.

The DOE response does not make it clear to what extent tracer isotopes will be used to establish analogous characteristics of the deposits. Thus, the NRC staff considers this question open. Progress toward resolution depends upon clarification concerning the extent of use of tracer isotopes at analog sites.

**References**

- Marshall, B.D., Futa, K., Peterman Z.E., and Stuckless, J.S., 1991, Strontium isotopes in carbonate deposits at Crater Flat, Nevada: Proceedings of the Second Annual International Conference on High Level Radioactive Waste Management, p. 1423-1428.
- Stuckless, J.S., 1991, An evaluation of evidence pertaining to the origin of vein deposits exposed in Trench 14, Nevada Test Site, Nevada: Proceedings of the Second Annual International Conference on High Level Radioactive Waste Management, p. 1429-1438.