



Department of Energy  
Washington, DC 20585

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Mr. Joseph J. Holonich, Director  
Repository Licensing & Quality Assurance  
Project Directorate  
Division of High-Level Waste Management  
Office of Nuclear Material Safety  
and Safeguards  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

References: (1) Ltr, Shelor to Linehan, dtd 12/14/90  
(2) Ltr, Bernero to Bartlett, dtd 7/31/91

Dear Mr. Holonich:

On December 14, 1990, the U.S. Department of Energy (DOE) transmitted its responses to the objections, comments, and questions presented in the U.S. Nuclear Regulatory Commission's (NRC) Site Characterization Analysis (SCA) (Reference 1). The NRC staff evaluated these responses, closing some comments and creating open items of the remainder (Reference 2). Two of the items identified as remaining open were comments 42 and 43 which expressed concerns relevant to the topic of erosion.

Enclosures 1 and 2 to this letter summarizes the administrative record with respect to SCA comments 42 and 43 and DOE's basis for resolution of each of these open items. NRC staff also requested additional Yucca Mountain Site Characterization Project documents for evaluation prior to resolution of comment 43.

The documents request by NRC and the additional documentation presented herein provide the basis to resolve both open items. With this submittal, DOE regards comments 42 and 43 as closed.

If you have any questions, please contact Mr. Chris Einberg of my office at 202-586-8869.

Sincerely,

John P. Roberts  
Acting Associate Director for  
Systems and Compliance  
Office of Civilian Radioactive  
Waste Management

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Enclosures:

1. Administrative Record for  
SCA Comment 42
2. Administrative Record for  
SCA Comment 43

cc w/Enclosures:

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R. Loux, State of Nevada  
M. Baughman, Lincoln County, NV  
J. Bingham, Clark County, NV  
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ENCLOSURE 1

SCA Comment 42 and DOE response (12/14/90)

NRC Evaluation of DOE Response (7/31/91)

Additional Information Relevant to SCA Comment 42 Open Item

COMMENT 42

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

BASIS

- o Previous NRC comment 35 suggested that the DOE include an evaluation of valley incision, sediment yield, uplift/subsidence, and escarpment retreat.
- o DOE has identified and included sections in the SCP which address hillslope erosion (which included valley incision) and uplift and subsidence (1.1.3.1.1, 8.3.1.6.1.1 and 8.3.1.8.3).
- o The DOE has also presented a justification for estimating approximate volumes of sediment eroded off hillsides instead of sediment yield studies for the short-term (8.3.1.1.6), and also expects to qualitatively estimate debris flow hazards (8.3.1.16.1.1).
- o Evaluations of escarpment retreat have not been included in the SCP. DOE suggests that escarpment retreat is indirectly treated in Activity 8.3.1.6.1.1.3 (an analysis of hillslope erosion); however, no studies of escarpment retreat are described under that activity. Because of the critical relationship between the westernmost extent of the waste repository and the western face of Yucca Mountain, direct studies of escarpment retreat are necessary to provide sufficient data to evaluate the overall hazard of erosion at the proposed Yucca Mountain site (Purcell, 1986).

RECOMMENDATION

A direct evaluation of escarpment retreat, especially as it relates to the western face of Yucca Mountain should be included in the erosion program to evaluate the overall future erosion potential required by performance and design issues.

REFERENCES

Purcell, C. R., 1986, Potential erosion at the Yucca Mountain nuclear waste site: Letter report from LLNL to NRC.

RESPONSE

The concern that the erosion program does not include an evaluation of escarpment retreat is addressed in Activity 8.3.1.6.1.1.3, An analysis of hillslope erosion at Yucca Mountain. The one objective of the activity is to "determine the average rates of Quaternary hillslope erosion on Yucca Mountain in bedrock and surficial deposits." Rates of erosion in bedrock are essentially an analysis of escarpment retreat at Yucca Mountain. A separate study was not created for measuring escarpment retreat at Yucca mountain because rock-varnish dating of hillslope deposits on Yucca Mountain indicates

that hillslope erosion rates on the mountain are very low. Whitney and Harrington (1988) showed that well-varnished hillslope deposits on Yucca and Skull Mountains range from greater than 760,000 to 170,000 years old. Erosion of the bedrock in these areas can then be assumed to be negligible over the past 100,000 to 10,000 years.

REFERENCES:

Whitney, J.W., and Harrington, C.D., 1988. "Scanning Electron Microscope Method for Rock-Varnish Dating," Geology, Vol. 15, pp. 967-970

Section 8.3.1.6 Overview of the Erosion Program

SCA COMMENT 42

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

EVALUATION OF DOE RESPONSE

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

Additional information relevant to SCA comment 42 open item:

The following information is provided in response to the NRC evaluation of the DOE response. This response provides the additional information needed by the NRC to resolve this SCA comment.

DOE does indeed use the term "hillslope erosion" synonymously with the term "escarpment retreat." A separate study was not created for measuring escarpment retreat because it was not considered necessary. Rock-varnish dating of hillslope deposits on Yucca Mountain indicates that erosion rates on the mountain are very low. Escarpment retreat of the steep-sided western ridge crest of Yucca Mountain cannot be greater than hillslope erosion for the less steep toe of the west face because escarpment retreat and hillslope erosion are in equilibrium. Rock-varnish dating abundantly confirms this.

The NRC staff indicated that closure of this issue must await evaluation of Activity 8.3.1.6.1.1.3 and attendant technical procedures. A study plan for 8.3.1.6.1.1 and the technical procedures identified in SCP Section 8.3.1.6.1.1.3 have not been, and are not planned to be, developed. As discussed below the parameters that were to be obtained by Activity 8.3.1.6.1.1.3 have already been obtained by three other ongoing, NRC-accepted study plans. Further justification for such action follows.

Figure 8.3.1.6-1 from the SCP shows how, in concept, the data inputs from 8.3.1.6.1 and other SCP studies were to be used to derive the information and analyses anticipated from SCP Section 8.3.1.6. The exact amounts of data to be gathered by each investigation and component study was not well known at the time the SCP was prepared, but these relationships were understood to the extent needed to present a sound planning basis. Compiling and deriving site characterization parameters in specific studies that were collected or calculated in other SCP studies and investigations does lead to a degree of duplication in the structure of the SCP. This overlap allows investigators to realize important insights between closely related topics.

Figure 1 shows how DOE's site characterization studies on erosion were carried out in primarily three ongoing studies. These ongoing studies have been reviewed and accepted by the NRC and include: Study Plan 8.3.1.16.1.1, "Characteristics of Flood Potential of the Yucca Mountain Site," accepted by the NRC in a Phase I review letter dated May 8, 1991; Study Plan 8.3.1.5.1.4, "Analysis of the Paleoenvironmental History of the Yucca Mountain Region," accepted by the NRC in a Phase I review letter dated December 6, 1991; and Study Plan 8.3.1.17.4.6, "Quaternary Faulting in the Site Area," accepted by the NRC in a Phase I review letter dated October 3, 1991. None of these review letters expressed any objections with the studies, but they did have requests for references and other minor concerns to which DOE is preparing separate responses.

SCP Section 8.3.1.6 specified 19 site characterization parameters to be delivered from the four studies (8.3.1.6.1.1, 8.3.1.6.2.1, 8.3.1.6.3.1, and 8.3.1.6.4.1). Study 8.3.1.6.1.1 is the only data-gathering study for erosion in SCP Section 8.3.1.6. Parameters in the other 3 studies are, (1) compiled primarily from other SCP studies, or (2) derived from primary materials generated in other SCP studies. An example of a compiled parameter is parameter 1 of Activity 8.3.1.6.1.1.3, "the absolute ages of the rock varnish coatings of bedrock and surficial deposits", is compiled from work performed to determine the several parameters in Activity 8.3.1.5.1.4.1, "Surficial

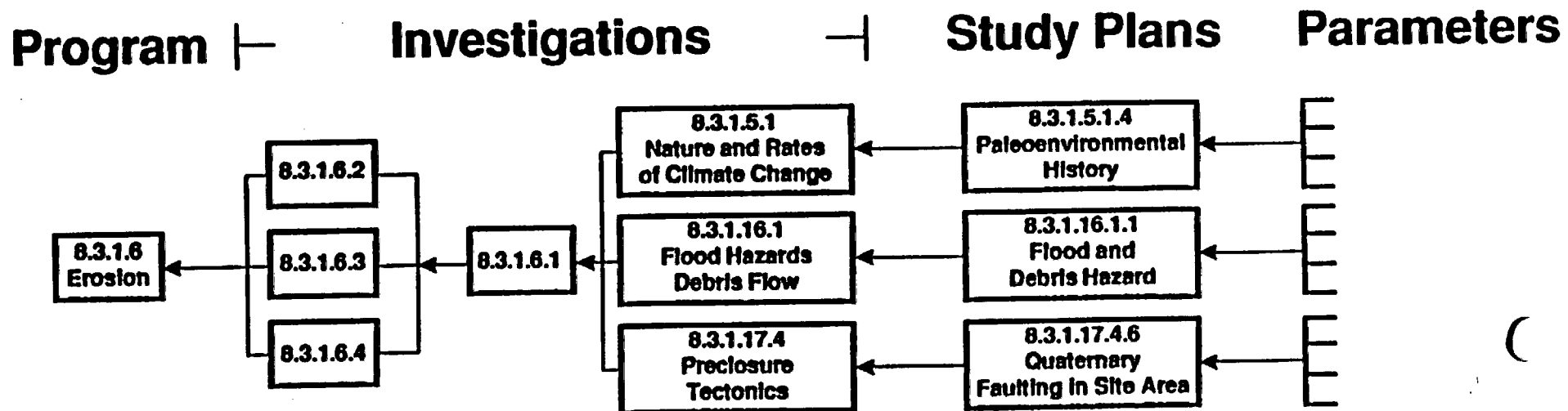
deposits mapping of the Yucca Mountain area." An example of a derived parameter is the geomorphic map to be done under Activity 8.3.1.6.1.1.3 is actually derived from the surficial geology map generated in Activity 8.3.1.5.1.4.2. Because most of the site characterization parameters in SCP Section 8.3.1.6 are derived from other studies, 8.3.1.6 in large part constitutes four investigations that collate data and call out evaluations relevant to determining erosion rates, processes, and locations.

This situation arose because early emphasis was placed on gathering site specific data relative to these studies, and as a result, these study plans were developed, approved, and implemented first. The study plans identified above and in Figure 1 provide data for the parameters sought by the erosion studies identified in SCP 8.3.1.6.1.1.3. These study plans provide the details necessary to demonstrate that adequate and sufficient site characterization data has been gathered. The topical report presents the results of these studies and contains the evaluations that were to be made under Section 8.3.1.6.

DOE considers that the study plans identified above, the topical report on erosion, and the additional documentation presented herein closes this open-item.



# HOW APPROVED STUDY PLANS RELATE TO EROSION PROGRAM



Preliminary Draft

ENCLOSURE 2

NRC Comment 43 and DOE response (12/14/90)

NRC Evaluation of DOE Response (7/31/91)

Additional Information relevant to SCA Comment 43 Open Item

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

#### COMMENT 43

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

#### BASIS

- o 10 CFR 60.122 (a) (2) (ii) requires that the natural conditions on the site be "adequately evaluated using analyses ... and assumptions which are not likely to underestimate" the effect of those conditions.
- o Regional, long-term rates of erosion averaged over time and applied to specific areas do not provide a conservative estimate of potential erosion which could occur over a short time period during a single erosive event. Failure to consider maximum conditions in predicating erosion over the next 10,000 years may result in an underestimation of the effect of potential erosion.
- o Numerical goals assigned for acceptable limits for fault movement appear to be unrealistic. The performance measure of the probability of 5 cm of fault displacement on faults in the repository area or at the location of facilities important to safety (FITS) may be unattainable in light of difficulty in ascertaining lateral movement along faults in the Yucca Mountain area (See Comment 48).
- o The use of slip rates provides an average value for fault offset of a number of faulting events over time, but fails to consider the potential for single events of maximum slip or offset (see Comment 48).
- o The use of the 10,000 year cumulative slip earthquake concept normalizes and averages the amount of fault displacement over time and does not provide a conservative estimate of maximum fault movement resulting from a single episode (See Comment 66).
- o Averages of cone counts through time are likely to underestimate the rates of volcanic eruptions over a given period of time (in this case, the Quaternary of 2.0 million years) (Geological Society of America, 1988). This method of calculation does not appear to provide a process for accurately estimating the potential of volcanic activity and,

therefore, the potential disruption of the repository that could occur as a result of a volcanic eruption (See Comment 45).

- o Faulting potential based on the "average spacing of Quaternary faults that is estimated for the structural domain" (p. 8.3.1.17-62) is a nonconservative parameter which may underestimate the potential for faulting.

#### RECOMMENDATIONS

- o DOE should provide goals that are not likely to underestimate maximum single-event disruptions, rather than providing estimates of cut-off values or goals which are based on averaging of established values over time.
- o Alternatively, DOE should plan to demonstrate that average values are conservative values.

#### REFERENCES

Geological Society of America, 1988, The decade of north American geology time scale.

#### RESPONSE

At several recent meetings and technical exchanges, the U.S. Department of Energy (DOE) has attempted to explain to the U.S. Nuclear Regulatory Commission how and why numerical goals were used in the referenced tables and elsewhere in the Site Characterization Plan (SCP). DOE's intent, as stated in the SCP and discussed at various technical exchanges, was to use "goals" as a logical early step in performance allocation, where the objective was to help scope the technical aspects of the site characterization program. These goals are not, and should never be, considered as performance goals. Best estimates were based on available data, professional judgments, and understanding of various applicable regulations. The process allowed scientists and engineers to make logical plans for their work. For example, if the performance allocation goal is 5 cm of offset on a fault, the scientist or engineer writing the Study Plan knows that the activities conducted at scales of several meters of offset is inadequate, or vice versa. The intent and practice is to use goals to scope and focus study plans but never to limit necessary observations. For the same example, a fault with 4 cm of offset would be studied as thoroughly as one with 6 cm of offset or 6 or 60 m of offset. However, it may not be prudent, in this case, to expand time and resources to determine if offsets were 1 mm as distinguished from 2 mm.

Justifications for performance allocation goals do not require the rigor of a performance goal. DOE believes that the performance allocation goals are sufficient to meet their intended purpose. See also the response to Comment 1.

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

SCA COMMENT 43

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

EVALUATION OF DOE RESPONSE

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

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

Additional information relevant to SCA Comment 43 open item:

The following information is provided in response to the NRC staff evaluation of the DOE response, and supplies the supporting materials needed by the NRC to resolve this comment.

With respect to the generic topic of performance goals, the DOE is aware that the concept of performance allocation goals has been difficult for reviewers to understand. The values for the goals specified in SCP Table 8.3.1.17-3a, 8.3.1.17-4a and b, and 8.3.1.17-7 are not to be used for assessment of potential hazards. The use of averaged values or rates for establishing acceptable limits for fault movement, rates of volcanism, and rates of erosion was done to establish an expected order of magnitude for these values. DOE does not consider a greater specificity in the selection of goals necessary, because whether a specific goal is met or not does not mean the site necessarily meets or does not meet the system performance assessment requirements defined in the regulations.

If the performance goals established in the SCP were in fact met, the writers of the SCP believed that these parameters, when used collectively, probably would be adequate to demonstrate suitability of the site. Exact parameter goals would not have to be met individually, but collectively, they were likely to be able to demonstrate whether or not the site meets performance objectives based upon a total system performance assessment. The values for goals are intended to be demonstrated through iterative performance assessment calculations. These calculations are to be performed both during and after site characterization and would be the basis for determining if a particular performance measure is sufficient to meet total system performance objectives.

In conducting the performance allocation process for each of the performance issues, as described in SCP Section 8.1.2 (Issue Resolution Strategy), performance measures were established for various elements of the repository system, including the natural and engineered barriers. These measures relate to the aspects of the system, such as characteristics, conditions, or processes that affect performance with respect to the regulatory requirements. The identification of tentative goals in no way reduces the burden on DOE to characterize the site and the conditions and processes that are important in evaluating long-term performance of a repository system. The natural system, as it exists, must be understood sufficiently well to provide high confidence in decisions regarding site suitability and licensability. The goals represent a preliminary judgment of what constitutes adequacy. If the site-specific values for the site characterization parameters are sufficiently different from the goals to indicate that the regulatory requirements may not be met, the strategy for demonstrating system compliance would have to be re-evaluated. If the data indicated that any poorer-than-expected performance could not be mitigated, then the suitability of the site would need to be reassessed.

In addition to the selection of goals, the staff indicated that several documents would need to be evaluated to close this open item. The DOE has provided all of the requested documents to the NRC.

In the NRC's evaluation to DOE's response to comment 43, the DOE/Yucca Mountain Site Characterization Project's (YMP) Test and Evaluation Plan (T&EP) was requested. The T&EP was sent to the NRC on April 30, 1991 (ltr.

Shelor to Linehan).

Also in NRC's evaluation of DOE's response to comment 43, the NRC cross-referenced their evaluation of responses for comments 1, 48, and 66. Comments 48 and 66 are not applicable to this discussion. The DOE/YMP Technical Support Documentation Management Plan (TSDMP) was requested in NRC's evaluation of DOE's response to SCA Comment 1. The TSDMP was sent to the NRC as an enclosure in the same letter that sent the T&EP. Also requested was the baselined portions of the SCP (Site Characterization Program Baseline (SCP)). A controlled copy of this document was sent to the NRC on July 15, 1991 (Ltr. Shelor to Linehan). The Secretary of Energy's "Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program" is a DOE document (DOE/RW-0247), and as such is readily available. DOE documents are distributed to NRC, at multiple addresses, under the uniform distribution system of the Office of Scientific and Technical Information at Oak Ridge, Tennessee. The Test Prioritization Task report, "Testing Priorities at Yucca Mountain: Recommended Early Tests to Detect Potentially Unsuitable Conditions for a Nuclear Waste Repository" was sent to the NRC on January 23, 1992 (Ltr. Roberts to Holonich). Explanations as to the role and scope of all of these documents was included in DOE's transmittal letters.

DOE considers that the transmittal of these documents and the additional documentation presented herein completely closes this open item.