

**REVIEW OF:**

**DOE Report "Early Site Suitability Evaluation of the  
Potential Repository Site at Yucca Mountain, Nevada"**

**Prepared for the Nuclear Regulatory Commission  
Contract No. NRC-02-88-005  
Account No. 20-3702-021**

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## 1. INTRODUCTION

A review of DOE report "Early Site Suitability Evaluation of the Potential Repository Site at Yucca Mountain, Nevada" has been conducted in accordance with the "Statement of Work" received from the NRC Contract Officer (S. Mearse FAX to H. Garcia on April 22, 1992). According to this statement of work and the verbal technical direction provided to A. Chowdhury by B. Jagannath, the scope of this activity is limited to the technical review of sections/subsections: 1.0 - Introduction; 2.3.3 - Rock Characteristics Technical Guideline (Postclosure); 2.3.7 - Postclosure Tectonics Technical Guideline; 2.4 - Evaluation of the Postclosure System Guideline; 3.0 - Evaluation of the Preclosure Guidelines; 3.3.3.2 - Rock Characteristics Technical Guideline (Preclosure); 3.3.3.4 - Preclosure Tectonics Technical Guideline; and 4.0 - Summary and Recommendations. The objectives of this review are to: (i) determine if DOE's application and interpretations of the siting guidelines are consistent with those concurred upon by the Commission, and (ii) determine if technical evaluations are free of any major concerns, there is inconsistency in the use of data, all data have been considered, or there are concerns related to interpretations. According to the verbal and written technical direction received from the NRC RDCO Element Manager (B. Jagannath FAX to A. Chowdhury on April 30, 1992), this review does not include comment on DOE's use of expert judgement for Early Site Suitability Evaluation (ESSE), or determination of whether DOE's peer review process for the ESSE is consistent with the NRC's guidance on peer review for high-level waste repositories (NUREG-1297).

The DOE conducted ESSE primarily to determine early in the site characterization program if there are any features or conditions at the site that indicate it is unsuitable for repository development. A secondary purpose was to determine the status of knowledge in the major technical areas that affect the suitability of the site. The DOE used the qualifying and disqualifying conditions of 10 CFR Part 960 to classify the ESSE suitability findings into three groups: (i) unsuitability finding, (ii) lower-level suitability finding, and (iii) higher-level suitability finding. If the evidence supports a conclusion that a disqualifying condition is present or is likely to be present or that a qualifying condition cannot be met or is unlikely to be met, then the result is an unsuitability finding. A lower-level suitability finding is the negation of an unsuitability finding. A lower-level finding can be supported when current information does not indicate that the site is unsuitable. There is, however, a possibility that additional information could change the conclusion, and thus, that the site could still be found unsuitable. A higher-level suitability finding can be supported when it is judged unlikely that future information could change the conclusion. This finding would occur when there is high confidence in the conclusion drawn from available information. A higher-level finding does not necessarily mean that remaining uncertainties concerning the site's ability to satisfy a guideline have been resolved. Rather, the higher-level finding means that resolving any remaining uncertainties is unlikely to change the current conclusion about suitability of the site.

The review findings on the sections/subsections of ESSE report which are within the scope of this review are presented below.

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**2. CONSISTENCY BETWEEN NRC CONCURRED SITING GUIDELINES AND THEIR APPLICATION BY DOE**

DOE's application and interpretation of the siting guidelines for the sections/subsections of the ESSE report which have been reviewed herein are found to be consistent with those concurred upon by the Commission.

**3. NEW ISSUES OR CONCERNS THAT COULD NEGATIVELY IMPACT THE SITE OR PROPOSED SITE INVESTIGATIONS**

The following questions and comments are presented in the format established for the Site Characterization Plan (SCP) review.

**Section 2.3.3.1 Statement and Discussion of Qualifying and Disqualifying Condition**

**QUESTION 1**

Why were the effects of the mining operations and thermal loads on the ability of the Calico Hills Unit to contain and isolate waste not considered in assessing the Qualifying Condition [10 CFR 960.4-2-3(a)]?

**BASIS**

- In the discussion of Section 2.3.3.1, it is stated that "confidence is needed that mining operations during repository construction and the heat generated by the emplacement of wastes will not cause deleterious fractures or thermal alteration in the host rock that could significantly diminish the ability of the site to contain and isolate waste." Discussion of similar concerns for the Calico Hills Unit was not provided.
- Extensive drifting, about 12,000 feet, in the Calico Hills Unit, directly underneath the emplacement horizon, is proposed in the Strategies 2 and 5 of the Risk/Benefit Analysis of Alternative Strategies for Characterizing the Calico Hills Unit at Yucca Mountain (DOE, 1991). Although the excavation in the Calico Hills Unit will be substantially limited as compared to the excavation in the emplacement horizon, the impact of mining operations and thermal alterations may be more pronounced on the Calico Hills Unit than on the host rock for waste emplacement, given that the former is much weaker and contains more heat-sensitive minerals than the latter. The uniaxial compressive strength of the Calico Hills Unit is about six times less than that of the host rock unit and the modulus of elasticity is about four times less (DOE, 1987).

## RECOMMENDATIONS

- Consideration of the impact of the mining operations in and potential thermal alteration of the Calico Hills Unit should be included in the analysis of Qualifying Condition 10 CFR 960.4-2-3(a).

## REFERENCES

DOE, 1987. The Nevada Nuclear Waste Storage Investigation Project Reference Information Base, Version 03.001.

DOE, 1991. Risk/Benefit Analysis of Alternative Strategies for Characterizing the Calico Hills Unit at Yucca Mountain.

Sections 2.3.7.3.2.1 and 2.3.7.3.2.5

## COMMENT 1

New issues are often raised in the technical community. At least one is mentioned in the ESSE report, although not applied to the site area.

1. The possibility that the NTS Yucca Mountain region is underlain by a large deep East-Westerly trending shear zone that induces surface shear faulting at an angle to it.
2. The possibility that there are crust/mantle interface anomalies beneath the NTS-Yucca Mountain area that might be considered indicative of a partial volcanic melt at depth. Such a condition may effect probability estimates of future seismicity or volcanism in the area.

## BASIS

- NUREG 1347, NRC Staff Site Characterization Analysis of the Department of Energy's Site Characterization Plan, Yucca Mountain Site, Nevada, 1989, does not address that en-echelon faults at the surface may be controlled by a strike slip rift at depth, as has been discussed in the ESSE report. If such a feature is identified through field work, its activity during the Quaternary should be determined, if possible. This activity would only be partially manifested in surficial en-echelon faults and would be distributed among them. Therefore, there remains a possibility that if such a rift exists it may have a more significant impact on seismic and fault displacement hazard analyses than was recognized in the NUREG 1347.

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- The ESSE report cites anomalous heat flow beneath a region adjacent to the Yucca Mountain site. Other publications, since the ESSE, suggest the possible presence of a partial magma melt at the crust/mantle interface, e.g. Evans and Smith (1992). Jones (1992) suggests a mantle buoyancy anomaly in the Death Valley/NTS region. This information, taken together, suggests that there may be a possible impact on volcanic hazard assessment.

#### RECOMMENDATION

- Avoid high level resolution assessments for appropriate favorable or unfavorable conditions until these concerns and issues are better understood through acquisition of field data.

#### REFERENCES

- Evans, J. R. and M. Smith III. 1992. Teleseismic tomography of the Yucca Mountain region: volcanism and tectonism. Proceedings of the 3rd International Conference on High Level Radioactive Waste Management.
- Jones, C.H. 1992. Contributions of mantle bouyancy to variations in elevation in and around the Basin and Range inferred from crustal seismic velocity structures. (abstract) Seismological Research Letters V63:38.

#### 4. ASSESSMENT OF ESSE REPORTS FINDINGS

The ESSE reported lower-level and higher-level findings for the disqualifying and qualifying conditions of the sections/subsections within the scope of this review. These are summarized in Table 1.

Table 1. Summary of ESSE Findings for Selected Sections/Subsections

Sections/Subsections	Disqualifying Condition	Qualifying Condition
2.3.3 - Postclosure Rock Characteristics	Not Applicable	Present, Lower-Level Finding
2.3.7 - Postclosure Tectonics	Absent, Higher-Level Finding	Present, Lower-Level Finding
2.4 - Postclosure System	Not Applicable	Present, Lower-Level Finding
3.3.3.2 - Preclosure Rock Characteristics	Absent, Higher-Level Finding	Present, Lower-Level Finding
3.3.3.4 - Preclosure Tectonics	Absent, Higher-Level Finding	Present, Lower-Level Finding

The lower-level findings in Table 1 for the qualifying conditions indicate that the site is likely to meet the conditions, but additional information could change the conclusion. On the basis of the currently available information, this review agrees with these findings.

The higher-level findings in Table 1 for the disqualifying conditions for postclosure tectonics, preclosure rock characteristics, and preclosure tectonics are, in some cases, supported by small amounts of data compared to that which will be available when underground exploration and investigation will be underway. For example, predictions based on mining experience suggest that several times as many faults may be identified in underground workings as were identified from surface exploration. If this holds true for Yucca Mountain, the added information may or may not support higher-level findings for preclosure and postclosure tectonics. The higher-level finding for the disqualifying condition for preclosure rock characteristics relates to the health of personnel during repository construction and operation. The ESSE states that reasonably available ventilation and health protection technology is adequate to mitigate the concern over the uncertainty of the health effects of the zeolite mordenite in the Calico Hills Tuff. However, it seems that the uncertainties referred to in the ESSE make the assigning of a higher-level finding problematic without referencing techniques that may be relevant to mitigating possible health hazards.