

MAY 18 1988

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MEMORANDUM FOR: B. Joe Youngblood, Chief  
Operations Branch, HLWM

FROM: Ronald L. Ballard, Chief  
Technical Review Branch, HLWM

SUBJECT: RESPONSE TO DOE'S LETTER (R. STEIN TO B.J. YOUNGBLOOD,  
UNDATED) ON CHARACTERIZATION OF THE REPOSITORY BLOCK AT  
YUCCA MOUNTAIN DURING SITE CHARACTERIZATION

In a letter from J. Linehan to C. Gertz dated August 28, 1987, the NRC staff formally communicated to the DOE a technical concern over whether proposed drifting from the main test level of the Exploratory Shaft Facility (ESF) would enable the NNWSI Project to gather data representative of the entire repository block. This concern was an outgrowth of the April 14-15, 1987, meeting on the Exploratory Shaft Facility in which proposed changes to plans for the ESF were outlined by the DOE. In a letter from R. Stein to B.J. Youngblood (undated, document control date: 3/11/88), the DOE responded to the NRC concern. As a follow-up, in the meeting between the DOE, State of Nevada, and the NRC to review NRC's comments on the Consultation Draft of the Site Characterization Plan (CDSCP) (March 21-23, 1988), the DOE representative requested an early reply to DOE's letter so that the results could be considered in preparation of the statutory Site Characterization Plan. This memorandum presents the technical staffs' response to the DOE's undated letter.

Staff members from the Geology/Geophysics and Geotechnical Engineering/Design sections have reviewed the DOE's response (R. Stein to B.J. Youngblood, undated) to the NRC concern about the representativeness of data collected in the ESF and conclude that the DOE response has not resolved the concern expressed in the August, 1987, letter to C. Gertz. The NRC staff still considers that the DOE's program may not provide reasonable assurance that the data derived from the proposed area of drifting and surface-based tests will be sufficient to establish the geologic conditions and the ranges of those parameters at this site.

Specifically, the DOE addressed the NRC concern by: 1) citing test programs defined in the Consultation Draft of the Site Characterization Plan (CDSCP), and 2) indicating, albeit incorrectly, that the NRC staff had used an outdated outline of the repository in the basis for its concern. With respect to the testing programs outlined in the CDSCP, the NRC staff in its review of the CDSCP expressed continuing concern that the testing program outlined might not adequately characterize the entire repository block. This concern is based on the inherent problems of using boreholes to define structural and lithologic features and is outlined in two CDSCP Comments and one Question (Comment #'s 28 and 100 and Question # 13) included as Attachment 2. With respect to the

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outline of the repository, the NRC staff used the reference document for the April 14-15, 1987, NRC/NNWSI project Exploratory Shaft Facility meeting as the reference for boundaries of the repository. The boundaries for the repository shown in this document are similar to those shown in the CDSCP. In any event, DOE's elimination of the southern part of Area 1 has only indirect impact on the NRC concern. This concern does not rely specifically on the outline of the proposed repository, but is based on 10CFR60.2 which requires establishing the geologic conditions and ranges of those parameters at the site and 10CFR60.122(a)(2)(i) which requires that potentially adverse conditions be adequately investigated, including the extent to which the condition may be present and still be undetected.

The NRC Staff makes the following recommendations for consideration by the DOE to substantively address the concern over the representativeness of the data collected during Site Characterization. First, we recommend that the DOE address the recommendations outlined in CDSCP Comments 28, 100 and Question 13 (Attachment 2). Specifically the DOE should:

- 1) Demonstrate that the program of drifting and systematic drilling will provide the information necessary to ensure that conditions and processes encountered are representative of conditions and processes throughout the site,
- 2) Compare and evaluate the benefits and disadvantages between more extensive drifting during site characterization (including supplemental horizontal core drilling) and the surface-based systematic drilling program with respect to data derived and effects on performance.

Second, we recommend that if the DOE has further questions about the NRC concern, a meeting be held among the NRC, the DOE, and the State of Nevada, to address those questions.

Attachment 1 to this memorandum provides detailed responses to specific items raised in the DOE's letter. Because the DOE's "Specific Responses to NRC Concerns" in Enclosures 1 & 2 to R. Stein's letter referred to plans in the CDSCP upon which comments have previously been made or were based on a misunderstanding of the basis for our concerns, no specific response to items in Enclosures 1 & 2 was deemed necessary.

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Ronald L. Ballard, Chief  
Technical Review Branch, HLWM

Enclosure:  
As stated

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ATTACHMENT 1

Responses to Specific Items in R. Stein's Letter to B.J. Youngblood

DOE Item: (Page 1, 1st para., 4th sentence) "...DOE has proceeded with design efforts with the understanding that the NRC had generally agreed with the overall concept proposed by DOE as well as the specific changes presented."

During discussions at the April 14-15, 1987, meeting the NRC noted that no drifting was planned to explore the southern and western portions of the proposed repository. NRC staff expressed concern over the increase in the effects of faulting in the southern part of the repository as noted in technical reports by Scott and Bonk (1984) and Scott and Castellanos (1984). At that time the DOE stated that details of the surface-based exploration program, to include the southern part of the repository, would appear in the SCP. As this topic, and the topic of representativeness of the proposed insitu/surface-based testing program was not considered to be a specific part of the agenda and beyond the scope of the meeting, the topic was left open. The topic of representativeness of data derived during site characterization should be considered as an agenda item for upcoming DOE/NRC interactions where an agreement on this topic could be reached.

DOE Item: (Page 1, 2nd para., 2nd sentence) "These staff comments appear to be based on the assumption that the NNWSI project repository outline shown in the Environmental Assessment (EA) corresponds to the more recent Site Characterization Plan (SCP) Conceptual Design Report."

The NRC staff has been aware of the changes made to the proposed repository outline from that defined in the Environmental Assessment. Comments made in the staff analysis in the August 28, 1987, letter to Mr. Carl Gertz were, in part, derived from extrapolation northward from Scott and Bonk's (1984) C-C' cross section with the assumption that geologic features, particularly fault zones, do not abruptly end but might continue northward to the repository block. This assumption is based, in part, on the higher dips on the primary foliation noted in the southeastern part of the repository block (i.e., 13° and 19° vs. 5° to 7° on Yucca Mountain crest) and the apparent reversal in dip of the Ghost Dance fault from west to east (Scott and Bonk, 1984). Scott and others (1983) indicate that where dips exceed approximately 10° to 20°, abundant small-displacement north-northwest-striking faults appear.

In addition, while the DOE indicates that "The current placement of the perimeter drift for the underground facility specifically excludes the densely faulted area ..." (R. Stein letter to Mr. B.J. Youngblood, undated, document control date: 3/11/88), Appendix M of the SCP-Conceptual Design report indicates that the area southeast of the current repository including the imbricate fault zone outlined on Scott and Bonk's map could be an extension to the primary repository block and recommends that site characterization include:

"...exploration to the southeast of the primary area to reduce uncertainty in the southeastern boundary of the primary area in order to determine how much additional area can be qualified there. This will be done by lateral drifting from the ESTF to determine the usability of ground with imbricate normal faults..."

DOE Item: (Page 1, 2nd para., 6th sentence) "...the DOE has recently completed a consultation draft of the Site Characterization Plan (SCP/CD) for the Yucca Mountain site which describes the plans to obtain information relevant to your concerns."

The NRC staff has reviewed the Consultation Draft Site Characterization Plan and has commented (Comments 28 and 100, Attachment 2) that "The program of drifting and Systematic Drilling (designed to acquire site-specific subsurface information) outlined in the CDSCP appears inadequate to provide the lithologic and structural information necessary ..." and "Borehole penetrations into the main waste storage area ... may not provide the representative information needed to construct a three-dimensional geologic model of the repository block and to evaluate ranges of parameters that could affect repository performance."

Generally, the basis for these comments is derived from the uncertainty in detecting significant structural and lithologic features in boreholes. Many of the difficulties in using boreholes to detect structural and lithologic features are outlined in the CDSCP and referred to in CDSCP Point Papers, Comment #28 and Question #13 (Attachment 2).

References:

DOE, 1987, Proposed changes to the Nevada Nuclear Waste storage investigations Project exploratory shaft facility: background paper for the U.S. Nuclear Regulatory Commission and State of Nevada Agency for Nuclear Projects, Nuclear Waste Project Office.

Scott, R.B., and Bonk, J., 1984, Preliminary geologic map of Yucca Mountain Nye County, Nevada with geologic sections: U.S. Geological Survey Open-File Report 84-494, Scale 1:12,000.

Scott, R.B., and Castellanos, M., 1984, Stratigraphic and structural relations of volcanic rocks in drill holes USW GU-3 and USW G-3, Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-491, 121 p.

Scott, R.B., Spengler, R.W., Diehl, S., Lappin, A.R., and Chornak, M.P., 1983, Geologic character of tuffs in the unsaturated zone at Yucca Mountain, southern Nevada, in Mercer, J.W., Rao, P.S.C., and Marine, I.W., eds., Role of the unsaturated zone in radioactive and hazardous waste disposal: Ann Arbor Science Publishers, Ann Arbor, Michigan, p. 289-335.

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Section 8.3.1.4.2, Geologic Framework of the Yucca Mountain Site, p. 8.3.1.4-32.

COMMENT 28

The program of drifting and Systematic Drilling (designed to acquire site-specific subsurface information) outlined in the CDSCP appears unlikely to provide the lithologic and structural information necessary to construct a reliable three-dimensional geologic model of the repository block or insure that observations made will be representative of conditions and processes throughout the repository.

BASIS

- ° 10CFR60.122 provides generally that the DOE must demonstrate that the effects of potentially adverse conditions (e.g., faulting in the Quaternary) have been adequately studied to assure that the condition does not compromise the performance of the repository.
- ° Chapter 8.3.1.8 states that "If deformation was found to be significant enough that the requirements for waste package performance could not be met, the changes required in repository geometry may be such that the repository would no longer be able to accommodate the specified volume of waste " (p. 8.3.1.8-27).
- ° Section 6.1.2.1.4 notes that the subsurface expression of faults and fractures is important to underground design because they introduce uncertainty in the determination of the potential thermomechanical response.
- ° The area within the perimeter drift has been said to contain a significantly lower concentration of faults relative to surrounding areas (p. 8.3.1.4-33). However the southeastern part of the repository block is in the Abandoned Wash block which is described as containing many north-northwest striking fractures and faults which have displacements of 3 m or less and where beds have dips as steep as 70° (U.S.G.S, 1984).
- ° The Solitario Canyon fault borders the repository on the west and is a major block-bounding fault. The subsurface expression of this fault zone appears to be largely unknown.

## Systematic Drilling Program:

- ° The description of Investigation 8.3.1.4.1 indicates that the integrated drilling program is dependent on satisfactorily resolving regulatory concerns about drilling within the boundaries of the repository perimeter drift.
- ° Chapter 8.3.1.4 notes that core recovery from the unsaturated zone is typically poor (p. 8.3.1.4-39) and that careful analysis of core segments will not eliminate many sampling limitations inherent to the study of fractures in near-vertical coreholes (p. 8.3.1.4-73).

- ° Wilder and Yow (1984) have documented the difficulty of noting and understanding fault zones in drillcore.
- ° Section 8.3.1.4.2.2.3 states that careful reconstruction of core segments will not eliminate many of the sampling limitations that are inherent to the study of fractures in near vertical coreholes and that fracture dimensions will not be attainable from core due to the small sample size.

#### RECOMMENDATIONS

- ° Demonstrate that the program of drifting and systematic drilling will provide the information necessary to ensure that conditions and processes encountered are representative of conditions and processes throughout the site.
- ° If regulatory concerns about drilling as noted in 8.3.1.4.1 are not resolvable then the program for investigating potentially adverse conditions in the southern part of the repository appears inadequate. In this case, alternate methods of investigating potentially adverse conditions in the southern part of the repository should be outlined.
- ° Compare and evaluate the benefits and disadvantages between more extensive drifting during site characterization (including supplemental horizontal core drilling) and the surface-based systematic drilling program with respect to data derived and effects on performance assessment.
- ° Show that the goals and plans for the drifting and systematic drilling programs are integrated with the goals and plans for the geophysical exploration program.

#### REFERENCES

NRC, Letter from J. Linehan, NRC, to C. Gertz, DOE, Dated August 28, 1987, Subject "NNWSI Project: Drifting and Representativeness."

USGS (U.S. Geological Survey) (comp.), 1984, A summary of geologic studies through January 1, 1983, of a potential high-level radioactive waste repository site at Yucca Mountain, southern Nye County, Nevada: U.S. Geological Survey Open-File Report 84-792, 103 p.

Wilder, D.G., and Yow, J.L., Jr., 1984, Structural geology report Spent Fuel Test--Climax Nevada Test Site, Lawrence Livermore National Laboratory, UCRL-53381, 43 p.

#### REVIEW GUIDES

4.2.2, 4.3.4



## Section 8.4.2.4 Exploratory Drifts, page 8.4-35, paragraph 3 and 4

COMMENT 100

The extent of site exploration described in the CDSCP indicates that the DOE plans to explore only a small portion of the underground repository block through underground testing and drifting. Substantially more drifting may be necessary to reduce uncertainties about the presence of faults and other geologic and hydrologic conditions. In the CDSCP no exploratory drift is planned to cross the main waste storage area to the southern portions of the block, which based upon existing information appears to contain more faults and fractures than other parts of the block. Borehole penetrations into the main waste storage area (boreholes from the surface, horizontal core drilling or other means) may not provide the representative information needed to construct a reliable three-dimensional geologic model of the repository block and to evaluate ranges of parameters that could affect repository performance.

BASIS

- ° The exploration, as proposed in CDSCP, covers only a relatively small and peripheral area in the north east portion of the block. The proposed drifting and testing has not been demonstrated as being sufficient to establish the ranges of the parameters required by the site characterization as defined in 10 CFR 60.2. See also Reference 2.
- ° Exploratory drifting across the entire proposed facility has been used in the past in other repository projects (Ref. 3). A similar approach at Yucca Mountain site is likely to yield valuable information about the range of variability of site parameters and will substantially reduce uncertainties.

RECOMMENDATIONS

- ° The SCP should show that the proposed underground exploration and testing together with surface-based site characterization, would sufficiently establish the geologic conditions and the ranges of important geomechanical, hydrologic and other needed parameters across the entire repository block. Alternatively, additional drifting to yield a more complete and representative characterization of the repository block should be proposed.

REFERENCES

1. 10 CFR 60.2
2. Letter from J. Linehan, NRC to C. Gertz, DOE, dated August 28, 1987, Subject "NNWSI Project: Drifting and Representativeness."
3. "SPDV Shaft Outfitting and Underground Excavation", WIPP-DOE-197, 1984.

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4.2.5

## Section 8.3.1.4.1 Integrated drilling program

QUESTION 13

Discussions of the integrated drilling program are unclear. How will drilling or tests be coordinated so as to prevent possible interference; how will various studies be integrated; how will data from various holes be used in support of different studies; how will uncertainty in core retrieval and data analysis be handled; and how will the large volume of existing information be used to plan the drilling program? Explain.

BASIS

- ° Activities associated with proposed drillholes listed in Table 8.3.1.4-2 reflect a concern with the impact of drilling and drilling media upon the saturated zone and hydrologic characterization of the unsaturated zone, but consideration should also be given to the impact of drilling upon tests to be conducted or in progress in surrounding holes.
- ° It is not clear whether data obtained from holes conducted for one particular investigation or discipline will be utilized as possible input into other investigations (e.g., data from water level drilling as input to geologic studies).
- ° It is unclear to what extent the proposed program will be implemented. For example, page 8.3.1.4-37 states that "three additional continuously cored holes may be drilled."
- ° Information from core may be limited with respect to mineral fillings, fractures, and faults due to the small sample size and the difficulty in recognizing certain features in core. Vertical holes may not intersect many major rock discontinuities such as near vertical faults and fractures.
- ° Difficulties may arise in interpretation of core, as "core recovery is typically poor in the unsaturated zone" (Page 8.3.1.4-39).

RECOMMENDATIONS

- ° The integrated drilling program should supply relevant data from drillholes to all investigations and clearly state the proposed program of exploration.
- ° Drill core may be inadequate to provide information on many parameters; the SCP should propose alternative methods for determination of parameters.
- ° Some angled drillholes should be considered.

- ° At an early stage in planning the drilling program, qualified existing information should be integrated and evaluated to identify information still needed.
- ° Planned drilling programs should be integrated with planned drifting and geophysical programs.

REVIEW GUIDES

4.3.5, 4.3.6