EI DOCUMENT REVIEW SHEET

FILE NO: 1085-010

DOCUMENT: Comments on the Nevada Nuclear Waste Storage Investigations (NNWSI) Exploratory Shaft Conceptual Design Report (LA-9179-MS), DOE Response to the April 14, 1983, NRC Letter from Coplan to Vieth, June 7, 1985.

REVIEWER: Engineers International, Inc.

DATE APPROVED:

DATE REVIEW COMPLETED: August 22, 1985

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

This document is in response to NRC's concerns on exploratory shaft construction and sealing as identified in the letter of April 14, 1985, from Coplan to Vieth. The concerns are primarily related to the ability of the ES to permit the acquisition of adequate information for site characterization and the assurance that the ES activities will not compromise subsequent long term isolation and containment capabilities of the repository, as mandated by 10 CFR60.10. Furthermore, if the ES is to be incorporated in the repository, its construction and sealing

plans need to be reviewed to ensure that the licensibility requirements (10CFR60 Subpart D) and the quality assurance standards (10CFR60 Subpart G) are met, and that the ES faciliities will be able to meet the performance objectives of 10CFR60.111 and 113.

SUMMARY OF DOCUMENT:

Each information need identified in the 1983 NRC letter is addressed, however, response to several items are incomplete since future plans in many areas are yet uncertain. Essentially, the thrust of the information provided appear to de-emphasize the need for stringent construction controls, quality assurance, and long-term seal designs, on the premise that the ability of the repository to meet NRC and EPA release criteria is not significantly dependent on ES construction and sealing techniques.

Two attachments are provided with the document, consisting of excerpts from the Technical Specifications for ES excavations and the draft ES Test Plan. The ES construction and testing plans, as presented, are summarized below.

The exploratory shaft facility (ESF) is to be located in Coyote Wash on the eastern side of Yucca Mountain at an elevation of about 1,300 m (4,150 ft). The facility will consist of

- the ES-1 shaft: 3.66 m (12 ft) finished inside diameter, to a depth of 451 m (1,480 ft)

- a landing and a test drift at the 158 m (520 ft) level (also called upper demonstration breakout room (DBR))

- a landing and 396 m (1,300 ft) of drifts and rooms at the 366 m (1,200 ft) level (designated as the test level)

- a drill room at the bottom of the shaft (also called lower DBR)

- the ES-2 shaft: 1.83 m (6 ft 4 in.) finished diameter, from the 366 m (1,200 ft) level to the surface, for ventilation and emergency egress.

Construction of ES-1 is planned using the conventional drill-and-blast shaft sinking technique. The drifts and rooms are also planned to be mined using drill-and-blast methods. The ES-2 will be constructed by drilling a pilot hole to the 366 m (1,200 ft) level, attaching a larger diameter reaming bit at the bottom of the drill string, and then up-reaming the shaft back to the surface.

Tests will be conducted in the ES-1 proper as well as in drifts and rooms at the three breakout levels and in the main testing facility at the 366 m(1,200 ft) level. No formal tests are currently planned from the ES-2.

ES testing is currently envisaged to consist of the following:

- shaft-wall mapping, photographing, and hand specimen sampling conducted after each mucking round

- large-block sampling for porewater analysis, age dating, and laboratory geomechanical testing at 15 to 30 selected locations

- saturated-zone water sampling each time water inflow occurs

- vertical and lateral coring to confirm adequacy of geologic and hydrologic conditions before breakout at the upper DBR, the test level, and the lower DBR

- tests to assess constructability and stability of repository-size drifts in the upper and lower DBRs

- shaft convergence tests, between the upper DBR and the test level

- permeability tests at the upper DBR and the test level.

PROBLEMS, LIMITATIONS, AND DEFICIENCIES:

Many of the major conclusions provided in this document have been obtained from the performance analysis of ES design and construction (Hunter, 1985). The review comments on that document are therefore applicable to this study as well.

Although the document provides responses to each item of the 1983 NRC letter, the information provided is incomplete in many areas. For example, the design specification and acceptance criteria for the shaft construction, seal placement methods, remedial methods upon inadequate seal performance, test and inspection activities during construction and liner placement, and quality assurance procedures are not presented since these plans are expected to be developed in the future.

Other concerns and limitations of the document are discussed below.

1. It is acknowledged in the DOE letter that the conclusions of this document are based on "preliminary data and unverified assumptions." However, the recommendations made on the basis of these conclusions do not seem to reflect the uncertainty in the data and analysis procedure.

2. The possibility of encountering water-bearing zones from the shaft (such as fault zones and perched water zones) and plans for sealing these are not provided. Also, contingency plans need to be developed for unanticipated events.

3. Plans for sealing of the breakout rooms above and below the main test level are not discussed. The impact of these openings on the isolation capability of the ES as a repository shaft warrants consideration.

4. Plans for sealing of exploratory boreholes are not provided. Possible connection of the boreholes to sources of water need to be investigated.

5. The possibility that the shaft liner will be removed prior to decommissioning is mentioned (p 5 of Enclosure 1), however, little attention seems to have been devoted toward exploring the potential problems involved in this operation. The ability to safely remove the shaft liner at potentially unstable and/or water bearing zones may border on the limits of currently available technology.

6. The design of the underground structure and support in the ES are currently planned to be treated under quality Level II. This may be inappropriate in consideration of the role of rock support in preventing rock loosening and the extent of the damage zone. Until such a time that the DOE can conclusively demonstrate that the damage zone around the ES will not impact waste isolation, underground supports should be treated under quality Level I.

7. The minimum thichness of zeolitized Calico Hills tuff required to meet the performance criteria in 10CFR60 on pre-waste emplacement ground water travel times to the accessible environment is not stated (p 3, Enclosure 1). The NNWSI draft Environmental Assessment (EA) used a

value of 100 m as the minimum thickness. Based on generalized core logs from the principal borehole (USW-G4), the thickness of the zeolitized tuff is only 107 m, thereby permitting a penetration of only 7 m into the Calico Hills. DOE's current plans seem to indicate 22 m of penetration.

8. The rationale for the choice of horizons where controlled or "smooth" blasting is planned is not provided.

9. The size of "large-block" samples required and where the samples are planned to be taken from are not discussed. How will it be ensured that these samples will be unaffected by construction activities and yield representative results?

10. It is stated that visual examination of the core from the pilot hole ahead of the ES will be used to determine breakout depths. However, the criteria to be applied to make an optimum choice is not presented.

11. Several tests are planned from the upper DBR that are expected to provide information useful in constructing the main test level and the lower DBR. Due to the large vertical separation between each station and difference in stratigraphy, the usefulness of the data obtained at the upper DBR is questionable.

RECOMMENDED ACTION:

As indicated in the previous section, a number of plans and procedures for construction, testing, and inspection within the ES are yet to be developed. Tentative plans for these should be provided to permit evaluation of ES construction and testing program, as well as a realistic schedule for the finalization of these plans.

Other deficiencies and limitations identified in the earlier section should also be addressed. It appears that in light of the data uncertainties and the preliminary nature of the analysis on shaft sealing requirements, DOE should consider performing sensitivity analyses for the range of expected conditions and material properties in the ES. This would enable the reviewers to estimate the degree of confidence attributable to the conclusions and recommendations presented in this study.

United States Department of the Interior

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Denver Research Center
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August 22, 1985

Mr. David Tiktinsky
Engineering Branch
Division of Waste Management
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Nuclear Regulatory Commission
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Dear Dave:

Enclosed are review comments on the documents entitled "Performance Analysis Studies to be Used in Determining Quality Assurance Levels for the Exploratory Shaft Design and Construction Activities".

If we can provide further assistance for this document review, please phone me at FTS 776-0741 or Kanaan Hanna at FTS 776-0760.

Sincerely,

R. L. Mundell

R. L. Mundell
Group Supervisor
Mine Design

Enclosure

cc: David R. Forshey, Wash. Office
Earl B. Amey, Wash. Office

WM-RES
WM Record File
B6934

WM Project 10,11,16
Docket No. ---
PDR ✓
LPDR ✓ B, N, S

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NNWSI EXPLORATORY SHAFT PERFORMANCE ANALYSIS DOCUMENT REVIEW

Document: Performance Analysis Studies to be Used in Determining Quality Assurance Levels for the Exploratory Shaft Design and Construction Activities

Reviewers: K. Hanna, D. Conover, and R. Kneisley

The review of the subject document was performed in conjunction with the review of the document entitled "Comments on the Nevada Nuclear Waste Storage Investigation (NNWSI) Exploratory Shaft Conceptual Design Report (LA-9179-MS)". We concentrated primarily on evaluating DOE's estimation of the extent of the damaged zone surrounding the exploratory shaft and the effect of the damaged zone on shaft stability and sealing. The review comments correspond to the first two NRC comments in Section I of the "Comments" document.

Comment 1 - Damaged Zone

We believe that DOE's estimate of the size of the damaged zone is reasonable, based on the following:

a) The methods used to estimate the extent of the damaged zone (Ref. 1) are logical and thorough and use conservative parameters where data are unavailable.

b) A previous Bureau of Mines study conducted to determine in situ stresses in tuff at the Nevada Test Site (Ref. 2) shows a stress profile around an underground opening which increases to a maximum level approximately 40 in. from the face and then decreases to undisturbed levels about 60 in. from the face. In addition, the presence of a blast damage zone caused by conventional blasting, extending approximately 1 ft. from the face is indicated by the inabiliy to obtain intact overcores. From this study, the extent of the damaged zone attributed to blasting and of the resulting

stress redistribution is expected to range up to 60 in. wide. The overcoring tests were conducted at a depth of 1,200 ft and suggested that no abnormally high horizontal stresses were present. These conclusions are consistent with the input parameters and results of reference 1.

c) A preliminary stability analysis (Ref. 3) indicated that the damaged zone may extend to 4 ft. into the shaft wall. Using the values of physical properties given in reference 4, the horizontal stresses should be less than those calculated in reference 3, with a corresponding reduction in the width of the damaged zone.

Determination of the width of the damaged zone is dependent upon in situ stress and rock physical property data, both which are currently not available. However, the range of the size of the damaged zone is expected to be small; the conservative estimate used by DOE should provide a reasonable basis for the associated permeability and flow analyses.

Comment 2 - Blast Damage

We agree with the proposed plan to use a smooth blasting technique on the periphery of the shaft to reduce overbreak and blasting damage. Because the permeability of fractured rock is thought to be proportional to the fracture spacing and the cube of the fracture aperture, every effort should be employed to reduce the generation of new fractures and/or the enlargement of existing fractures. We also concur with the estimate of blast damage set forth in reference 1 (5 to 10 times the hole diameter), which is consistent with current controlled blasting practice. We suggest that a pre-splitting technique be considered in addition to the proposed smooth-blasting technique, particularly in any highly fractured zones intersected by the shaft.

Comment 3 - Permeability Distribution

It should be recognized that the distribution of fractures in the damaged zone is not likely to be uniform and may follow preferential directions due to in situ stresses or anisotropy. Although the average permeability of the damaged zone may be comparable to DOE's estimate, high permeability zones may exist locally which could provide a preferential pathway for infiltrating water. Depending upon the backfilling materials and techniques used, such high permeability zones may also form in the backfill and could result in channeling and subsequent bypassing of the backfill plug.

Comment 4 - Floor Drainage

DOE presumes that the potential for the exploratory shaft to provide preferential drainage from the repository rooms to the Calico Hills unit has been minimized by assuming that most of the inflow water will drain through the floor of the repository drifts before reaching the shaft. It is, however, stated (App. B, Sec. 4.2.3, p. 27, 28) that drainage through the floor may be inhibited by an accumulation of fine material which may render the floor virtually impermeable, in which case all inflow water would be available for drainage through the shaft. We suggest that procedures, such as those described in reference 5, be implemented to minimize the accumulation of fines on the drift floor and/or provide means to enhance drainage through the floor.

Comment 5 - Shaft Liner and Shaft Internals

DOE has adequately discussed the effects of the shaft liner and shaft internals on shaft sealing; we have no additional comments.

References

1. Kelsall, P.C., J.B. Case, and C.R. Chabannes, A Preliminary Evaluation of the Rock Mass Disturbance Resulting from Shaft, Tunnel, or Borehole Excavation, ONWI-411, Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH, 1982, 132 pp.

2. Obert, L., In Situ Determination of Stress in Rock, Mining Engineering, Aug. 1962, pp. 51-58.

3. Hustrulid, W., Preliminary Stability Analysis for the Exploratory Shaft, SAND83-7069, Sandia National Laboratories, Albuquerque, NM, 1984.

4. Tillerson, J.R., and F.B. Nimick, Geoengineering Properties of Potential Repository Units at Yucca Mountain, Southern Nevada, SAND84-0221, Sandia National Laboratories, Albuquerque, NM, 1984.

5. Fernandez, J.A., and Freshley, M.D., Repository Sealing Concepts for the Nevada Nuclear Waste Storage Investigations Project, SAND83-1778, Sandia National Laboratories, Albuquerque, NM, 1984.

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July 26, 1985

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Dear Dave:

Enclosed are review comments on the document entitled "Comments on the Nevada Nuclear Waste Storage Investigations (NNWSI) Exploratory Shaft Conceptual Design Report (LA-9179-MS)."

If we can provide further assistance for this document review, please phone me at FTS 776-0741 or Kanaan Hanna at FTS 776-0760.

Sincerely,

R. L. Mundell

R. L. Mundell
Supervisory Mining Engineer

Enclosure
cc: D. R. Forshey, Assistant Director--Mining Research
Earle B. Amey, Staff Engineer

NNWSI EXPLORATORY SHAFT DOCUMENT REVIEW

Document: Comments on the Nevada Nuclear Waste Storage Investigations (NNWSI) Exploratory Shaft Conceptual Design Report (LA-9179-MS).

Reviewers: K. Hanna, D. Conover, and R. Kneisley

Date Review Completed: July 25, 1985

Comments

We generally agree with the DOE discussion and conclusions regarding the exploratory shaft construction, testing and sealing techniques, and procedures. However, the DOE conclusions were often based on unavailable references; therefore, our evaluation was limited to the subject document. Additionally, many of the DOE designs and procedures have not been completed; therefore, a thorough evaluation was not possible. Our detailed comments and suggestions are listed below.

Section 1: Shaft and Seal Design Consideration

NRC comment 1 - We generally agree with the conclusions but have not reviewed the reference on which the conclusions were based. Since quantifying water inflows and measurement of hydraulic conductivities is rated highest priority in the sealing program, what are the detailed experimental plans?

NRC comment 2 - The DOE conclusion does not specifically address the sealing technique to be used in the event that perched water is encountered.

NRC comment 3 - What remedial action will be taken or special seal design techniques used to account for excessive overbreak or blast fracturing? Although procedures should adequately monitor and control overbreak, what procedures are planned for occasional excessive conditions?

NRC comment 4 - None.

NRC comment 5 - It is suggested that pressure monitors be emplaced to measure the pressure in the shaft lining because of the possibility of water flow in fractures surrounding the shaft.

NRC comment 6 - None.

Section 2: Construction Plans and Procedures

We feel that conventional construction practices and quality control procedures are adequate, and that DOE has presented an adequate discussion.

Section III: Sealing or Grouting Plans and Procedures

Given the expected minimal sealing requirements at Yucca Mountain, we believe that adequate seals and placement techniques can be developed prior to decommisioning and the DOE discussion is adequate. However, further discussion is required in the event the exploratory facility is to be included with the repository, in which case the extremely long-term sealing capabilities must be substantiated.

Section IV: Construction Testing and Inspection Plans and Procedures
Section V: Plans and Procedures for Gathering Specific Information Related to Site Characterization

We generally agree with the DOE response because the test and/or inspection procedures are either based on standard engineering practice or have not yet been developed.

Section VI: Quality Assurance

No comment.