Dr. Donald Vieth, Director
Waste Management Program Office
U.S. Department of Energy
Las Vegas, Nevada

Dear Mr. Vieth:

The NRC staff has reviewed both the DOE June 7, 1985 letter and the supporting reference documents that provide information on exploratory shaft construction and sealing. This information was provided in response to our letter of April 14, 1983 (Coplan to Vieth).

The two broad areas of concern considered in our review are: 1) that the site characterization activities (e.g, construction of an exploratory shaft) will not compromise subsequent long-term isolation and containment capabilities of the repository; and 2) that plans for construction of the exploratory shafts will not preclude the acquisition of adequate information for site characterization. These two concerns are raised so that DOE commitments to construction techniques can be thoroughly examined prior to implementation.

Our April 14, 1983 letter identifies NRC information needs pertaining to six broad areas associated with exploratory shaft construction and sealing: 1) shaft and seal design considerations; 2) construction plans and procedures; 3) sealing and grouting plans and procedures; 4) construction testing and inspection plans and procedures; 5) plans and procedures for gathering specific information related to site characterization; and 6) quality assurance for all of the above. Specific NRC staff comments representing the official NRC position on the DOE's letter response associated with each of the above six areas are addressed in Enclosure 1. Additional comments from NRC contractors can be found in Enclosure 2.

In the subject letter dated June 7, 1985, the DOE has proposed construction methods (ES-1, drill and blast, ES-2, raise bore) for the two exploratory shafts. The NRC has no objection to the use of the proposed construction methods, provided that they are properly constructed and controlled with an adequate quality assurance program.

After reviewing the other information provided in the DOE letter of June 7, 1985 and the supporting references, the NRC has identified the following concerns which are addressed in Enclosure 1.

1. At this time the NRC cannot accept the conclusion, as stated in the DOE response, that the construction of the Exploratory Shaft Facility will not affect the ability of the site to meet the performance objectives of 10 CFR Part 60.

2. The construction controls as shown in Enclosure B of the DOE response appear to be weak and are unlikely to ensure that construction overbreak will be kept to a reasonable minimum.

3. The testing and exploration that will be performed in the exploratory shaft are stated to be contained in the reference document entitled the "Exploratory Shaft Test Plan." This document is not available for NRC review at this time. DOE should submit this document for NRC review as soon as it is completed.

4. In response to many of NRC's concerns, the DOE has stated that the effort needed to resolve these concerns has yet to be completed. These unresolved concerns are considered to be open items and are identified in Enclosure 1 as such. The DOE should provide schedules for completion of each of these open items. As the items are completed, the DOE should submit the information to NRC for review.

5. Since a decision has been made to construct a second shaft, the DOE should include a discussion of the construction and testing that will occur in the second exploratory shaft.

6. The NRC does not agree with the quality assurance classifications that the DOE has given to (a) the construction of the exploratory shaft; (b) the liner; and (c) the rock support and structure system.

The NRC concerns as stated in this letter and enclosures were discussed with you at the NRC/NNWSI Technical Meeting that was held on August 27-28, 1985. The NRC expects that after our comments have been considered by the DOE, an updated performance analysis and response would be submitted for NRC review.

If you have any questions about the attached material, please contact King Stablein of our staff at (301) 427-4611.

Sincerely,

John J. Linehan, Section Leader
Projects Section #1
Repository Projects Branch
Division of Waste Management, NMSS

Enclosures:
1. NRC comments on DOE letter of 6/7/85 and supporting reference on exploratory shaft construction and sealing.
2. NRC contractor comments.

Record Note: The technical review of the DOE June 7, 1985 letter and the supporting documents has been coordinated with the following staff members: Dinesh Gupta, David Tiktinsky, Tom Jungling, Jeff Pohle, Ted Johnson, John Trapp, Linda Kovach, Atef Elzeftawy, and Jim Kennedy.

rec'd w/memo dated 10/18/85 102 WM-11

DT/9/12/85/ENCL.

ENCLOSURE 1

NRC COMMENTS ON DOE'S LETTER OF JUNE 7, 1985

ON EXPLORATORY SHAFT (ES) CONSTRUCTION AND SEALING

I. Shaft and Seal Design Considerations

A. In response to the NRC comment requesting an analysis of the effects of construction of the ES on long-term sealing, the DOE has provided an analysis to determine the impact of the Exploratory Shaft on the long-term performance of the repository (DOE's Ref. 1, entitled "Performance Analysis Studies to be Used in Determining Quality Assurance Levels for the Exploratory Shaft Design and Construction Activities" dated July 2, 1985).

Based on a review of the DOE's performance analysis study, the NRC staff concludes that large uncertainties seem to be associated with the parameters used in the performance analysis. In addition, the scenarios utilized in the analysis may not represent an adequate bounding of the possible performance of the exploratory shaft, due to the limitations of the scenarios chosen. Therefore, at this time the NRC staff cannot accept the conclusion made in the reference document that construction of the Exploratory Shaft facility will not affect the ability of the site to meet the performance requirements of 10 CFR Part 60. The NRC staff's specific concerns with that conclusion and the underlying uncertainties include the following:

1. A total systems analysis should be performed, including, but not limited to, the effects of all ramps, shafts, and water producing fault zones on the volume of water coming in contact with the waste packages. In general, anticipated processes and events that must be considered in an evaluation of compliance with 10 CFR 60 performance objectives need to be considered.

2. A range of scenarios that might increase flood volumes due to lesser storm events (e.g., 20-year floods, annual floods) should be considered. It may be possible for the volume of water to be several orders of magnitude greater than that estimated in the performance analysis due to total runoff over a 10,000-year period (i.e., if runoff from surface rainfall was able to enter an unbackfilled shaft).

3. Scenarios that consider water escaping up the shaft(s) and ramps should be considered to determine whether they are credible events.

4. The DOE states that it considers the impoundment of water near the exploratory shaft to be a highly conservative condition and an unanticipated process (App.A, p.7). However, the NRC staff considers that an equivalent to this impoundment could be

achieved by an anticipated process, namely erosion, subsidence, and channelization at the surface, causing runoff to move along a preferred path directly toward the ES area. Since erosion, slumping, landsliding, and debris movement have been seen in many places on and about Yucca Mountain, the DOE should provide its rationale for considering such events to be unanticipated especially as they affect other shafts, ramps etc. as listed in Item 1 above.

5. Given the uncertainties about parameters included in the performance analysis report, the performance analysis should incorporate a sensitivity study which recognizes these uncertainties. For example:

   (i) Sensitivity of various flood parameters with respect to the total flood volume should be analyzed; and

   (ii) Sensitivity of the results of the analysis with respect to potential variability of significant parameters such as damaged rock thickness should be investigated to determine whether the numerical ranges should be expanded to more realistic (conservative) bounds.

6. The discussion contained in the Performance Analysis gives the perception that the problem of modeling waste package radionuclide releases is better understood than it actually is. The NRC staff considers that many of the assumptions do not appear to be substantiated; for example, it is assumed that the radionuclides are atomically dispersed within the matrix. Also, the analyses neglects the possibility of increased segregation as the linear power rating is increased in future commercial operations. As another example it is not clear whether the assumption of cracked fuel cladding means that all the cladding is assumed breached before the first event occurs or rather that the cladding is assumed to fail linearly with time from year 300 to year 10,000. Based on a failure mechanism such as stress corrosion cracking, such a slow failure rate is questionable. It is noteworthy that this failure rate is approximately 10 times slower than the rate assumed by Oversby (NNWSI-NRC waste package meeting 7/23-24/1985 - Also see Oversby and McCright, "Laboratory Experiments Designed to Provide Limits on the Radionuclide Source Term for the NNWSI Project," UCRL-91257, 1984) of 0.1% per year (1000 year total failure period).

7. The process in the performance analysis document by which the assumptions are made and the final conclusions are arrived at is not presented in sufficient detail that one could satisfactorily duplicate the analysis. For example, the report is ambiguous in terms of the volume of water which was used to calculate the radionuclide release. It appears that the volume of water directly above a waste container was assumed to contact the mass of waste within that particular container. However, it is not

obvious whether the radionuclide release was limited by the saturation of that volume of water or rather that the water was assumed to circulate (from thermal effects), thereby permitting fresh water to contact the waste and increase the dissolution and release of radionuclides. Also, it is not apparent whether the total surface area of each spent fuel rod was assumed to contact the water or if the total mass of the waste was taken as a single cylinder. This consideration may reduce the calculated quantity of radionuclides released.

8. The NRC staff does not find sufficient basis to accept at this time the conclusion in the Performance Analysis Report that the penetration of the Calico Hills formation by the Exploratory Shaft and the creation of a sump will not affect the integrity or ability of the site to meet the performance objectives of 10 CFR Part 60 (App.A, p.27). Specific staff concerns include the following:

   a) After contacting the waste, water may enter the Calico Hills formation via the exploratory shaft sump and chemically react with the zeolite mineralization in that horizon. This may compromise the sorptive capacity of that unit.

   b) There appears to be a discrepancy between the thickness of the Calico Hills presented in the performance analysis document and that determined by the NRC from the DOE literature (see Attachment 2, EI document review, August 15, 1985, Table 1). The NRC review of the data indicates that the Calico Hills may be substantially thinner at the exploratory shaft location than stated in the performance analysis document. This is important to the performance analysis in that the DOE assumes a thickness of 150 m (Hunter to Oakley letter, p.2) for the Calico Hills unit as a bounding value. In addition, it appears that the term Calico Hills is used to designate at least three different entities in the performance analyses: a geological unit; a geohydrological unit; and a thermomechanical unit. The DOE should establish consistency in the use of the term Calico Hills.

   c) The effect of the damaged zone on performance for the portion of the ES that penetrates into the Calico Hills formation has not been adequately discussed.

9. The value of hydraulic conductivity (10^{-5} cm/sec) was used in the performance analysis document (Hunter to Oakley letter, p.3). A realistic range of hydraulic conductivity, based on currently available data, should be used in the performance analysis.

10. The DOE's Performance Analysis Report considers that water flowing down the fault zones surrounding the ES would not flow to the ES because of the emplaced dams and/or drains. However, this scenario assumes adequate long-term performance of the emplaced barriers, and does not consider the implications of failure of those features. If these barriers are to be considered in future evaluations, their long term performance should be analyzed.

The NRC staff considers that these concerns about the potential effects of construction of the exploratory shaft on long-term sealing capability can best be analyzed by considering the entire pre-closure repository system and by using realistic assumptions for the range of significant parameters.

B. In response to the NRC comment on how the excavation technique and shaft design account for limitations and uncertainties in long-term sealing, the DOE states that it appears that long-term sealing is relatively independent of the shaft design and construction techniques (based on the performance analysis report). Nevertheless, the DOE states that they will keep construction overbreak to a reasonable minimum and document any overbreak that does occur. The NRC staff considers that it has not been demonstrated that the assumed rock damage due to excavation addressed in the report is conservative. Specifically, the rock damage calculations presented in the document are based on a finished diameter, not on the excavated diameters; they do not appear to consider any site specific stress or strength values; no consideration is presented for rock jointing; and the calculations do not consider the damaged zone in the portion of the Exploratory Shaft that penetrates the Calico Hills. While the commitment to document overbreak is satisfactory, the construction controls called for in Enclosure B of the response appear to be weak and not sufficient to ensure that construction overbreak can be kept to a reasonable minimum using the described controls. The NRC staff suggests that DOE should revise its construction control specifications for the selected excavation technique and shaft design to provide assurance that limitations and uncertainties in long-term sealing requirements have been accounted for.

C. In response to the NRC comment requesting design specifications for shaft construction and their effect on sealing, the DOE states that the design specifications for the shaft are not yet complete. In addition, the DOE states that based on their performance analysis report, the ability to meet the performance objectives is not affected by the degree of damage from construction and it is not necessary to show how the design specifications deal with factors affecting sealing.

The DOE should provide the NRC with a schedule for completion of the design specifications for the construction of the ES. After

completion of the specifications, the DOE should submit them to the NRC for review and comment.

In view of comment I(A), the NRC staff considers that the question of how the design specifications deal with factors affecting sealing remains an open item and the DOE needs to further investigate this question before a firm conclusion can be drawn.

D. In response to the NRC request for the seal design and materials, the DOE states that the seal designs and materials being considered for the Yucca Mountain site are described in the reference document "Repository Sealing Concepts." However, the DOE states that at the present time, it is not clear which, if any, of the seals described in the report will be needed in the repository. Because of the uncertainties in the Performance Analysis Report concerning the need for sealing (see NRC comments on I(A)), the NRC staff recommends that the DOE continue to pursue a program of developing long-term sealing capability (including degradation mechanisms of seals). In addition, the NRC considers that it is prudent for the DOE to carefully control rock damage due to construction of the shaft, in the event that future performance analysis indicates the need to seal such zones.

E. In response to the NRC request for information on testing to be performed in the shaft, the DOE states that the testing and exploration to be performed is described in the reference document entitled "Exploratory Shaft Test Plan." Since this document is not available to the NRC staff for review at his time, we consider this to be an open item.

The NRC staff recommends that the DOE provide early insight to the staff into proposed testing during exploratory shaft construction so that potential concerns can be identified in time for the DOE to factor them into their site characterization plans.

F. In response to the NRC request for the drilling history and geotechnical testing from the principal borehole, the DOE has provided the drilling history from the borehole, USW-G4 in a reference document entitled "Stratigraphic and Structural Characteristics of Volcanic Rocks in Borehole USW-G4," USGS-OFR-84-789. To complete the response to this comment, the DOE should provide additional available information that relates to geotechnical testing performed on samples obtained from this borehole for NRC review.

II. Construction Plans and Procedures

A. In response to the NRC request for the acceptance criteria for construction of the ES, the DOE states that specific acceptance criteria for the shaft are still being developed. In addition, it is stated that these criteria and their implementing construction controls need be no stricter from a sealing perspective than those

required for short term stability (based on the performance analyses report) and will be representative of good quality, state-of-the-art conventional shaft construction practices.

The NRC staff recommends that the DOE provide a schedule for completion of the acceptance criteria for the construction of the ES. After the acceptance criteria are completed, they should be submitted to the NRC for review and comment. In view of the Comment I(A), the NRC considers that the DOE has not provided an adequate basis for its position that the acceptance criteria need be no stricter than needed for short term stability.

B. In response to NRC's request to identify procedures used to minimize damage to the rock mass, the DOE states that the excavation procedures described in Enclosure A of the response (good commercial practices) will be adequate based on the insignificant impact of rock damage on long term performance.

The NRC staff considers that the DOE has not adequately justified the conclusion that the potential damage due to excavation would have no significant impact on the long term repository performance [see NRC comments on I(A)].

It appears to the NRC that it is unlikely that the excavation procedures as specified in Enclosure A will limit rock damage to reasonable levels, because no construction controls have been specified for a good portion of the exploratory shaft [see NRC comments on I(B)].

C. In response to NRC's request to identify the liner and construction and placement technique, the DOE presents a summary of the shaft and liner construction in Enclosure B of the response and states that the liner materials being considered have not been selected from a sealing point of view based on the Performance Analysis Report. In addition, the DOE states that the liner could be removed in the future if necessary to emplace suitable sealing components.

The DOE did not discuss the potential problems of removing the liner and the effect such removal will have on the rock surrounding the ES considering the length of time that the shaft will be in operation. In addition, unless a commitment is made by DOE that the shaft liner will be removed, an analysis should be performed on what effect leaving the liner in place will have on the integrity of the site (i.e., liner degradation and chemical effects from liner degradation.)

III. Sealing or Grouting Plans and Procedures

A. In response to NRC's request to describe the expected performance of seals in the ES, the DOE stated that the performance requirements for long term repository sealing at Yucca Mountain are expected to be

minimal based on the Performance Analysis Report. In addition, they also state that in view of the nature of sealing at Yucca Mountain and the time available prior to decommissioning in which to develop seals, the DOE is confident that the sealing requirement can be met.

Based on NRC comments on I(A) about the conclusions of the Performance Analysis Report concerning the need for sealing, we can not accept the DOE response to this question at this time. The level of performance that is necessary for the seals must be determined before it is possible to determine whether the sealing requirements can be met.

B. In response to the NRC request to describe the seal placement methods, the DOE states that the methods have not yet been developed pending establishment of the design requirements for sealing component.

The DOE should provide a schedule for development of seal placement method with respect to the need to establish design requirements for seals [see comment on III(A)].

C. In response to the NRC request to describe remedial methods to be used if sealing materials are not adequate, the DOE states that remedial methods for failure of long term seals placed during decommissioning have not yet been developed and need for remedial measures are believed to be minimal (based on performance analysis).

The NRC staff considers that the DOE's conclusions based on the performance analysis have not been adequately supported [see NRC comments on I(A)].

The DOE should provide a schedule for completion of the determination of what remedial method will be used if sealing methods are not adequate with respect to the need to establish design requirements for seals [see comment on III(A)].

IV <u>Construction Testing and Inspection Plans and Procedures</u>

A. In response to the NRC request to describe test and inspection procedures, the DOE states that test and inspection activities during ES construction, other than for site characterization are being developed and will be specified in the ESF Title II Design.

When completed, the DOE should submit to the NRC for review and comment, the test and inspection procedures that will be used in the shaft.

B. In response to the NRC request for test and inspection procedures for the liner, the DOE states that test and inspection procedures for the shaft liner are being developed as part of the Title II Design for the ESF.

When completed, the DOE should submit to the NRC for review and comment, the test and inspection procedures for the liner.

C. In response to the NRC request for test and inspection procedures to determine seal adequacy, the DOE states that test and inspection procedures for seal adequacy after decommissioning have not yet been developed.

When completed, the DOE should submit to the NRC for review and comment, the test and inspection that will be used to determine seal adequacy after decommissioning.

D. In response to the NRC request for detailed plans to document construction activities, the DOE states that detailed documentation plans have not yet been finalized for shaft construction activities and will be found in the Title III summary reports on construction.

When completed, the DOE should submit to the NRC for review and comment, the documentation plans for shaft construction activities.

V. Plans and Procedures for Gathering Specific Information Related to Site Characterization

A. In response to the NRC request for a description of test plans used to obtain data during exploratory shaft construction, the DOE states that plans for gathering data during ES construction are discussed in the reference document entitled "Exploratory Shaft Test Plan." In addition, they state that detailed procedures for data gathering have not yet been completed.

The reference document ESTP, is not available for review by the NRC at this time [see NRC comment on I(E)]. The DOE should submit to the NRC for review and comment when they are completed, the detailed procedures for data gathering.

VI. Quality Assurance

A. The NRC requested the DOE to identify the line of responsibility for implementing Quality Assurance. The DOE response was satisfactory and we have no comments on this item.

B. The DOE states that QA procedures for ES construction and testing have not been completed at his time. The DOE also presented a list of NNWSI systems for the Exploratory Shaft and has provided the quality levels that will be associated with those systems. The NRC has the following comments on this response.

1. The DOE should provide a schedule for completion of ES construction and testing QA procedures.

2. Regarding construction of the ES, the DOE has conducted a performance analysis of the ES demonstrating that rock damage

associated with construction of the shaft will not compromise the ability of the site to meet the NRC (10 CFR Part 60) and EPA criteria (40 CFR Part 191). In addition, on page 1 of the cover letter of the response (Vieth to Linehan, June 7, 1985), the DOE has concluded that the construction of the exploratory shaft is not an activity that impacts radiological health and safety of the public. As a result, the DOE has taken the position that construction activities of the ES do not need to be classified as Level I QA. Level I is defined in the NNWSI QA Plan (NVO-196-17) and prescribes that the NRC QA requirements in Subpart G of Part 60 be utilized. Level I also involves NRC review to assure that the requirements of Part 60 are being met.

The DOE indicated in their June 7, 1985 letter (page 2) that the conclusions presented (including those related to quality levels), were based on preliminary data and unverified assumptions. Further, the NRC staff has identified a number of concerns with the analyses presented [see comments on I(A)]. The staff therefore cannot agree at this time that Level II is an appropriate classification for ES construction activities. Either DOE should resolve the concerns and reduce uncertainties in the analyses (see NRC comments in I(A)) so that there is adequate confidence that the classification is correct, or should assume that exploratory shaft construction activities are Level I.

The staff believes the actual QA measures applied to specific construction activities could be identical whether they were classified Level I or Level II and need not necessarily be "elaborate" as DOE has indicated on Page 4 of their letter response. The principal difference would be the NRC review of Level I activities. The staff is ready to review the specific approaches DOE selects for assuring quality if Level I is required. This should be a topic for a future NRC/DOE technical meeting.

3. The DOE should indicate in the response what quality assurance level will apply to data collection during construction.

4. Based on the review of the given quality assurance designations the NRC does not agree with the classification of the liner and rock structure and support as Level II. These levels are based on the conclusions made in the Performance Analysis Report which the NRC cannot accept at this time (see comments on I(A)).

   In addition, the DOE should show additional justification for the QA classification of the dewatering system. If this system fails, then there is a possibility that the water that could not be removed may preclude the ability of the DOE to obtain some site characterization data about the unsaturated zone.

GENERAL COMMENTS

The DOE should in their response, discuss for each of the applicable information requests, as stated in the NRC to DOE letter (Coplan to Vieth, April 13, 1983), the second exploratory shaft that will be constructed.

ENCLOSURE II

This has been corrected

To: D. Gupta, NRC, WMEG

From: J. Daemen

Re: Comments on the Nevada Nuclear Waste Storage Investigations (NNWSI) Exploratory Shaft Conceptual Design Report (LA-9179 -MS). Letter from D.L. Vieth to J.J. Linehan, dated June 07 -85, with enclosures.

Date: 8-29-85

The fundamental claim made in the cover letter is that the construction of the Exploratory Shafts is not an activity that impacts radiological health and safety of the public. This claim is based largely on the performance analysis study, the conslusions of which have not been supported adequately by back-up analysis and data. Therefore the fundamental claim made in the cover letter can not be accepted.

Basic aspects of the Yucca Mountain site invoked in favor of the fundamental claim are:

- semiarid environment, hence limited surface water supply
- repository in unsaturated zone, hence limited groundwater entry into the repository, and easy drainage through the floor and away from the repository

Both arguments are valid technical arguments, and fundamentally alter probable sealing requirements when compared to other candidate repository sites, even though the numerical data and aspects of these arguments need to be firmed up considerably. Actual site-specific sealing requirements can be determined only on the basis of a site-specific performance analysis. This approach has been taken by NNWSI, based on its draft ES performance analysis study. The present draft, however, can not fully support the claim that the ESF will not perturb transport mechanisms to such an extent that the isolation potential of the site will not be compromised, mainly because this draft:

- considers only a very small number of release scenarios, and for example does not consider the presence of two exploratory shafts, nor of the simultaneous presence of multiple shafts and ramps, nor of thermal effects on water flow patterns. (This could be a significant impact, given the proximity of waste to ES-1 and ES-2; as a minimum an uncoupled analysis of temperature distributions and possible influence on water/steam/saturated air circulation would seem highly desirable).
- considers only a narrow range of numerical values (frequently only a single number) for parameters that could influence the results significantly (examples: fault zone or damaged zone thickness and hydraulic conductivity)
- does not consistently use conservative analyses

For these reasons, the main conslusion, that the construction of ES is not an activity that impacts radiological health and safety of the public is not adequately supported by the evidence presented.

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(The converse conclusion, that ES construction does impact radiological health and safety, can not be supported either by the analysis, because the analysis does include several possibly very conservative assumptions.)

The main conclusion of the cover letter pervades the entire DOE response: the detailed responses in Enclosure 1 repeatedly disclaim a need to respond, based on the conclusion. Before this DOE response can be accepted, it is essential that the main conclusion be established beyond any reasonable doubt. Even then, many of the detailed responses will not be acceptable, because the exploratory shafts will be part of the post-closure isolation system.

Detailed Comments

Note: the document reviewed here relies heavily on the ES performance analysis study. Redundancy in the review has been minimized by not repeating detailed comments already made in the review of that document. It is assumed that the reader is familiar with criticisms of the performance analysis study.

Enclosure 1

Page 1, I., Conclusions

For reasons discussed in the review of the performance analysis study the conclusion in the first bullet, that (radiological) public health and safety are not compromised during the post-closure period by the presence of a damaged zone near the ES is not acceptable because it is not supported adequately by analysis and data presented. (It is of some interest to note the qualifier "during the post-closure period", not used in the cover letter nor in the performance analysis study--pre-closure isolation or containment impact has never been addressed).

The testing commitment in the third bullet is excellent, and the results will provide data necessary for a much more reliable and realistic performance analysis.

page 1, last paragraph

Contrary to the statement in the first sentence of this paragraph, it is not obvious that the assumed rock damage because of excavation as addressed in the referenced performance analysis study is conservative. Specifically, the rock damage calculations as presented in the document are based on a finished internal diameter, not on the excavated diameter, do not consider any site-specific stress or strength values, do not consider the intense rock jointing, and do not take into account overbreak. The updated analysis presented by Kelsall during the 8-28 meeting is site-specific, and might well be conservative, although this needs to be checked.

While the commitment to document overbreak is laudable, the construction controls called for in Enclosure B appear to be extremely weak, and unlikely to ensure that construction overbreak will be kept to a reasonable minimum.

page 2, fifth paragraph, Response

The "Repository Sealing Concepts" report, Ref. 2, needs to be reviewed in detail, but a few general comments can be made:

- "sealing" relies heavily on long-term drainage through the floor
- "sealing" might rely heavily on dams and grout curtains in drift floors

page 2-3, Response

Shaft wall rock characterization appears to be very comprehensive. According to information provided at the 8-28 meeting, large blocks will be collected from the muckpile. This raises the "representativeness" issue, e.g. will the sample be biased because stronger than average rock survives blasting, rock is damaged by blasting , etc.

page 4, paragraph 6, Response

The blast criteria presented in Enclosure B (A?) are not good quality, state-of-the-art conventional shaft construction practice.

page 4, paragraph 8, Response

It is unlikely that the excavation procedures as specified in Enclosure A will limit rock damage to reasonable levels, because no controls are specified along most of the shaft.

page 4, paragraph 3, Response

The response reinforces the NRC request for a complete drilling history. Ref. 2, p. 69, does provide information on hole enlargement and poor conditions at several levels, and lost returns. Reference 4, page 56, last paragraph, specifically identifies drill hole enlargement and high fracture permeability in the Topopah Spring. A detailed analysis of G-4 information would provide a direct check on parameter values and analysis results used in the performance analysis study. Logs provided in Ref. 4 (last 2 pages) are difficult to read and to scale.

page 4, first and second Comment and Response in II

Controls in Enclosure A on blasting are minimal. A question that has not yet been addressed to any significant extent is whether or not blasting damage is likely to affect rock mass characterization, in particular shaft wall (fracture) mapping and testing.

page 5, top paragraph

Enclosure B gives no information on liner for second exploratory shaft.

page 5, section III

Sealing issues:

- addressed indirectly, through references, which need to be reviewed
- permanent sealing will be designed later, if required, and the information will be provided to NRC, if NRC needs it
- remedial action will be designed later, if needed

page 7, first response

In response to the last sentence, NRC needs to confirm that information is necessary and needs to be made available to NRC.

page 8, Discussion, point 1

This point contains several contradictions with the performance analysis study:

- it is claimed here that the shafts will be stripped of all internals, utilities, conveyances, and hoisting systems. According to the Shaft Performance Analysis (Hunter to Oakley letter, July 2, 1985, p.5., third paragraph), the internals of the six-foot diameter shaft can be left in place, and if so the shaft could continue its use as an emergency exit. This suggests that this shaft might become a significant aspect of the operational safety system. During the oral presentation on the ES Sealing (NRC-DOE Nevada, 8-28-85), a possible more intensive use of ES-1 during construction has been mentioned, i.e. utilizing the hoisting system during initial repository construction.

-Most of the Performance Analysis Study calculations are based on the use of one exploratory shaft. Adding the second shaft will add about twenty to thirty percent to the cross sectional flowpath area, and hence will increase water inflow into the repository (for the limiting steady state case) by about the same percentage. It is unclear by how much this would increase the flooded repository area, and hence exposure of waste to water.

-According to the Performance Analysis Study (Oakley letter, 7-2-85) the exploratory shaft will be used as the primary source of intake air for the waste emplacement operations. This in its own right clearly points out the extreme importance of the stability of this shaft. If, as claimed, all internals will be removed, regular inspection and routine maintenance of the liner, clearly necessary for a 50-70 year life, will be difficult and time-consuming (it will require moving some type of hoist above the shaft, and such mobile hoists always have very low hoisting speeds and capacities). A failure of the prime air intake (e.g. local shaft failure and air blockage) for the waste emplacement area operations could have major implications for air flow, airborne radionuclide removal, cooling, etc. No detailed assessment of the implications is possible, because several other air intakes (shafts, ramps) are available, and detailed implications would depend on how airflow is rerouted.

Additional comments raised by this point:

-When will ESF testing be completed? Specifically, will ESF testing continue as part of performance confirmation? When will internals from shafts be removed, and hence when will unobstructed air flow through shafts be possible, and when will routine inspection and maintenance of shaft liners become difficult?

<u>page 8, liner</u>

As discussed earlier, the liner might become an important operational safety item if the large exploratory shaft does indeed become the primary air intake shaft for waste emplacement operations. The importance of the liner would be enhanced if all internals were removed, as this would complicate shaft inspection, routine maintenance, and any remedial action that might be required over the life of the shaft (i.e. until permanent closure).

All indications are that the shafts, and hence their liners, will be part of the repository.

<u>page 8, Ventilation</u>

The statement that "ESF ventilation components are not intended to be used in the repository" presumably refers to Fans, doors, surface conduits, etc... It has been stated repeatedly that the shafts themselves will be part of the repository ventilation circuit.

<u>page 9, Hoist</u>

According to the Performance Analysis Study, the hoist in the small exploratory shaft may be left in place and become an emergency escape hoist for repository operations. Another option that remains open is that the ES-1 hoist may be used during initial repository construction (D. Vieth, Oral presentation, 8-28-85). In either case

one of the hoists would become part of repository operations.

page 9, Rock Structure and Support

It is very unclear to me what this statement refers to, and clarification from DOE would seem desirable. If this refers to the shafts, it overlaps with the previous Liner section, and the comments made there apply. If this statement refers to the underground test facilities outside the shaft only, then the following comments apply:

- 520 ft level breakout: total collapse would locally create a high permeability zone, and probably would locally affect shaft stability. Presumably this will be prevented by appropriate measures (e.g. dense backfill) at the time of ESF test completion, although no indication of this is given anywhere.
- 1480 ft level breakout: complete collapse would create a localized high permeability zone, enhancing drainage but compromising somewhat the geochemical barrier
- 1200 ft level breakout: assuming that some of the drifts on this level will become part of the operations ventilation system suggests that these drifts will have a significant role in operational safety, e.g. on a similar level as the intake shafts. Because these drifts always will be readily accessible for inspection, maintenance, and repairs, it is less critical than for shaft liners that durability and stability of these structures and their support be assured from the very early stages until permanent closure.

Enclosure A: U.S. Department of Energy; NNWSI ESF Project; Technical Specification Division 2-Site Work. Specification 02310 Excavation.

The document is preliminary, and only parts of it have been provided, so that the following comments can be considered tentative only.

02310-3 of 7, 3.1 Excavation

Section 3.1.2 provides monitoring and control for surface structures, based on outdated, but still widely used USBM specifications. Section 3.1.3 provides the apparently only control on excavation procedure. No monitoring is required, and no detailed limits are specified. Smooth wall blasting procedures are left entirely to the contractor, and unacceptable conditions include neither overbreak, rock damage nor liner damage.

The specifications include a direct quote from the Du Pont Blaster's Manual (pages 02310-6 of 7 and 7 of 7). The last sentences on page 6 of 7 state particularly clearly why smooth wall blasting in shafts usually is difficult: confinement relief is difficult to obtain.

The section quoted from the Du Pont Manual deals with tunnel (or mine drift) headings. It would be highly desirable to also include the section on shaft rounds, as the Du Pont Manual

recommends significantly tighter patterns (closer spaced holes) for shafts, and specifically suggests reducing the burden to less than the spacing in order to improve shear. It is unclear where Table II-Smooth Blasting (page 02310-7 of 7) is taken from, as I can not find it in the Controlled Blasting, Tunneling, or Underground Mining Chapters of my edition of the Du Pont Handbook. The spacings and burdens given in this table are identical to those in the Langefors and Kihlstrom "Rock Blasting" reference, which does not explicitly discuss shaft sinking, and the charge densities listed here as averages considerably exceed the values recommended in Langefors and Kihlstrom (by up to a factor of 3 for the smaller holes).

In summary, it is to be recommended that the blasting control specifications be tightened up considerably.

Enclosure B, page 6-13, top paragraph

The explanation of controlling the blasts lists maximizing vertical advance, minimizing shaft wall rock damage, and optimizing rock fragment size. These three objectives are partially in conflict, and priorities will need to be set. The sinking deck and associated equipment will be raised during blasting in order to avoid damage, but no indication is given as to liner protection requirements.

Enclosure B, pages 6-18/20

It is to be noted that the ground support at all three landings (intersections of shaft with breakouts) includes many steel components, obviously with limited durability.

No explanation is given as to what is meant by optimizing blast results (middle of second paragraph on page 6-18).

Enclosure B, page 6-22, Table 6-2

Schedule does not include time for shaft logging prior to liner installation.

Enclosure B, pages 6-24/26, ESF drift mining

No indication given as to whether any controls will be applied to mining (e.g. blasting, reinforcement) beyond conventional practice.

EI Document Review

File No: 1085-010

Document: Letter, T. O. Hunter, SNL, to D. T. Oakley, LANL, "Performance Analysis Studies to be Used in Determining Quality Assurance Levels for the Exploratory Shaft Design and Construction Activities", July 2, 1985

Reviewer: Engineers International, Inc.

Date Approved:

Date Review Completed: August 15, 1985

Significance To NRC Waste Management Program

Since the Exploratory Shaft (ES) facilities are likely to be incorporated into final repository design, an early assessment is required on the ability of the ES to meet the performance objectives of 10CFR60.111 and 113. In addition, the ES construction should meet the licencing requirements as specified by 10CFR60 Subpart D, and the quality assurance standards as specified by 10CFR60 Subpart G. This document seeks to define the standards to be applied in the design and construction of the ES and it is therefore important to evaluate the bases for the findings and conclusions presented therein.

Summary of Document

This document presents the results of a series of analyses performed by DOE with regard to the design and construction of the ES. Specifically, performance analyses have been performed in the following areas:

- to assess the potential for radionuclides to reach the accessible environment via the damaged rock zone (DRZ) around the ES
- to establish the performance required of the ES liner during the operational and post-closure phases of the repository
- to establish the role of the shaft internals in the ES during repository operations.

The results of the first two analyses are presented in detail, while the latter is briefly mentioned.

Three basic mechanisms of possible radionuclide release are investigated, namely:

- surface water drainage down the ES
- subsurface water inflow in the repository from a discrete fault
- airborne release of radionuclides through the ES

The first scenario assumes that all the water from a 500-year flood (equivalent to 86,000 m^3 of water) reaches the waste canisters through the ES. A 40-acre emplacement area of the repository is estimated to be flooded based on the perconceptual design of the repository. The quantity of radionuclides entering into the water by matrix dissolution is estimated and the value is inflated 20 times to project the radionuclide release quantity over 10,000 years. These release quantities are compared to the NRC and EPA criteria for radionuclide release rates and limits.

The second scenario considers a situation where ground water enters the repository from a fault zone, contacts the waste and then flows downgrade in the drifts toward the ES. The ES then acts as preferred pathway for radionuclide migration towards the ground water table. Estimates of possible flow quantities entering through the fault zones are made, as well as quantities that eventually reach the ES. Finally, an assessment of whether the ES will significantly affect radionuclide migration to the water table is presented.

The airborne release scenario only considers the mechanism for convective air flow through shafts, ramps, drifts and the host rock. The model used does not couple heat transfer and air flow. The resulting flow calculations have been used to estimate the possible impact of this mechanism on radionuclide release to the accessible environment.

Each scenario mentioned above have been evaluated under the assumptions that a damaged zone will exist around the ES and that the ES and the repository drifts will be backfilled with a material whose properties are not currently known (hydraulic conductivity of the backfill has been varied in the analyses between 10^{-6} to 10 cm/s). The damaged zone model used is a simplified one which assumes a uniform zone of rock, having a permeability that is 2 orders of magnitude higher than undisturbed rock, extending one radius from the shaft wall.

In addition, the effect of ES penetration into the Calico Hill unit is explored although detailed analysis of this is to be performed later. Since the Calico Hill unit is at least 125 ft thicker near the ES than elsewhere in the repository area, the 70 ft or so penetration into the unit, DOE does not expect that pre-waste emplacement travel times will fall below 1,000 years as specified in the siting guidelines.

The conclusions drawn from these analyses seem to indicate that the radionuclide releases that may occur as a result of water inflow through the ES or discrete faults, or due to airborne transport should be well below the NRC and EPA limits, if each mechanism is considered in isolation. In addition, the presence of the damaged zone around the ES is not likely to affect the post-closure isolation capability of the repository system.

The overall recommendation made on the basis of the above findings is that the ES construction techniques and quality assurance (QA) standards adopted need not consider the sealing aspects of the repository. The construction controls and level of QA need only be adequate from a short term stability viewpoint. Furthermore, the shaft and drift backfills do not need to conform to quality standards demanded from a sealing viewpoint. Further studies are recommended to assess the drainage capacity of the Topopah Spring Member, confirm the extent and hydraulic conductivity of the damage zone, and the quality of water inflow from discrete sources.

Problems Limitations and Defeciencies

The document presents analyses based on a set of assumptions, the validity of which will eventually determine the significance and reliability of its findings. Overall, many of the assumptions appear to be fairly realistic and sometimes overly conservative, however, a few assumptions may need to be reevaluated for their validity and degree of conservatism. These are discussed below.

1. A flux of 0.5 mm/yr is assumed for the calculation of travel time through the Topopah Springs and Calico Hills members (page 2 of letter). This value was previously reported in the DOE Draft Environmental Assessments (EA) and was strongly questioned by NRC (see NRC Comments on the EA - Major Comment 3, page 3, and Detailed Comments 6.31, page 53, and 6.45, page 62).

2. The performance assessments have assumed the thickness of the zeolitized Calico Hills formation to be 150 m (page 2 of letter). This is probably an overestimate in light of the thicknesses of the Calico Hill unit above the water table shown in Table 1 (see also Figure 1 for borehole locations). Furthermore, the Draft EA assumed a value of 100 m in the travel time calculations (page 6-137, DOE, 1984)

   The distance between repository horizon and the water table (assumed to be 200 m on page 3 of Appendix A) may be similarly overstated.

3. The hydraulic conductivity of undisturbed host rock is assumed to be 10^{-5} cm/s (page 20, Appendix A). This data was apparently derived from assumed fracture spacings and aperture widths (Fernandez and Freshley, 1984). The range suggested on the

Table 1 Variation of the Calico Hills Unit in the Vicinity of the Repository Block (based on generalized core logs provided in Fernardez and Freshley, 1984)

Hole No.	Thickness of Calico Hills to water table m (ft)	Vertical Distance between base of Calico Hills and the Static Water Table m (ft)	Calico Hills Zeolitized ?
UE-25a#1/ UE-25b#1	54 (176	-	No
USW H-1	107 (351)	-	partially
USW H-3	29 (95)	298 (977)	N.A.*
USW H-4	104 (342)	14 (47)	N.A.
USW H-5	72 (235)	114 (375)	N.A.
USW H-6	39 (128)	68 (222)	N.A.
USW G-1	115 (376)	23 (75)	Yes
USW GU-3	45 (147)	N.A.	No
USW G-4	107 (352)	5 (15)	Yes

* Data Not Available

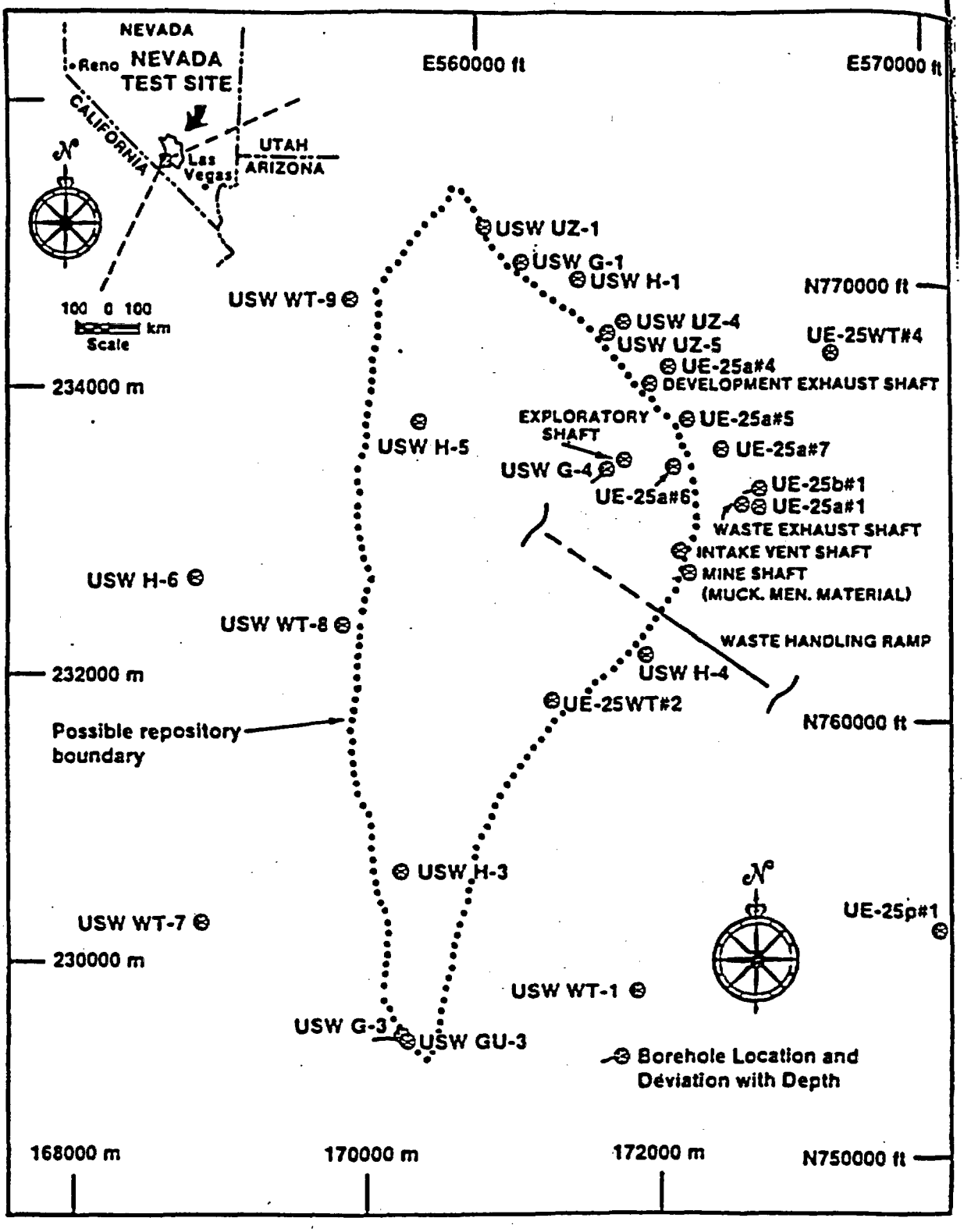

Figure 1. Location of Boreholes and Proposed Shafts Within and In the Vicinity of a Possible Repository Boundary (From Fernandez and Freshley, 1984)

basis of the few measurements in that study was 1.8×10^{-6} to 3.7×10^{-4} cm/s. These values did not take into account the interconnecting and cross joints, lithophysal cavities, or other heterogeneities that may further affect hydraulic conductivity. Thus, the assumed value of 10^{-5} cm/s may not be conservative enough.

4. The estimated portion of the repository waste emplacement area likely to be affected by flooding has been shown to be 40 acres based on proposed drift gradients in the preconceptual design. This estimate does not take into account the following uncertainties:

   - the final repository design may be different from the preconceptual design
   - there may be other sources of water supplementing the water inflow from the ES (e.g. fault zones, perched water zones, other shafts and ramps)
   - any blockage of flow downdip of the ES may result in flood water flowing updip to adjacent panels.

   In view of these uncertainties, the estimate of the area affected and, consequently, the number of canisters in contact with water may not be realistic. This is an extremely important variable, one that could invalidate most of the major conclusions cited in this study.

5. The model of the damaged zone (page 20, Appendix A, page 5, Appendix B) assumed in the analysis appears to be rather simplistic, and since it is based on a basalt model its applicability to tuff is uncertain. Other questionable assumptions in this regard include:

   - the increased permeability zone is assumed to extend one radius away from the shaft. This needs to be verified. Further, the excavated diameter of the shaft should be used instead of the finished diameter (14 ft as approach to 12 ft)
   - the assumed permeability of the damaged zone may not be conservative enough
   - as shown by the Keisall et al (1982) study the permeability increase close to the shaft wall is about 3 orders of magnitude higher. The assumption of uniform permeability increase within the one-radius distance neglects the

possibility that water would tend to flow preferentially through the highest permeability zone and reach the repository much faster than that predicted by average flow. Also, this high permeability zone may increase in extent due to the passage of time through erosion and alteration

- other factors that may affect the extent and nature of the damaged zone, such as stress field, geologic structure, tectonic processes, and the like are not taken into consideration.

6. The water inflow calculations from fault zones and flow to the ES, and the assumed hydraulic conductivity values for the fault zones may not be conservative enough for the following reasons:

   - the analysis of water inflow from faults considers the Ghost Dance Fault in isolation and does not consider secondary fault systems that may contribute to the total inflow (page 24, Appendix B)

   - the analysis assumes that the effective rock mass hydraulic conductivity for welded tuff to be representative of the hydraulic conductivity of the fault zone (page 26, Appendix B). Due to the highly sheared and fractured nature of typical fault zones, a much higher value of hydraulic conductivity is more realistic

   - although water bearing fault zones are said to have been intercepted in tunnels at the Nevada Test Site, (page 23, Appendix B) these data were not included in inflow estimates

   - the drainage characteristics of the repository floor would influence to a large extent on how much water reaches the ES. However, this was not considered in the calculations. The comparison of the total floor area of the repository to the area of the ES should be of little significance.

7. The amount of radionuclide released into the ground water is computed by assuming that water comes in contact only with the horizontal cross-section of the waste canister (page 13, Appendix A). In reality, though, the entire surface area of the

canister will be contacted by water. Consequently, the computed values of release quantities may be different under this assumption.

8. The airborne release amounts are estimated on the basis of a single transport mechanism and does not couple heat transfer and airflow (page 31, Appendix B). Although this shortcoming is acknowledged, no effort has been made to attach a factor of safety to the results for the sake of conservatism.

Recommended Action:

The document concentrates on areas that are extremely critical to the success of the site characterization program as it evaluates the likelihood of the ES facilities in altering the post-closure isolation capability of the repository. In so doing, the document makes several sweeping conclusions and recommendations, namely:

- control of damaged rock zone around the ES is not important
- QA standards during ES construction need not be stringent
- shaft and drift backfills are of little significance.

These findings, if endorsed by the NRC, could lead to significant reduction in the levels of detail of information to be provided by DOE in its site characterization plans (SCP). In addition, it may result in little emphasis being given to construction procedures, design of shaft liners, control of adverse effects, shaft sealing plans, and QA requirements during ES conditions and testing. It is therefore imperative that each assumption, analysis procedure, and result be thoroughly reviewed, preferably by a team of multi-disciplinary staff composed of geohydrologists, waste package analysts, geochemists, and rock mechanics engineers.

The principal areas that need to be reevaluated include:

- water volume calculations for the various flooding scenarios
- water inflow volumes through faults
- hydraulic conductivity for the rock mass, damaged zone, and fault zone for the different tuff units
- drainage capacity of various tuff units

- relationship between various site specific factors and the extent of the damaged zone

- the rate of dissolution of radionuclides into contact water

- radionuclide release associated with a combination of different release mechanisms, such as flooding of ES accompanied by other water inflows from fault zones or other openings.

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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August 22, 1985

Mr. David Tiktinsky
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Division of Waste Management
Office of Nuclear Material Safety & Safeguards
Nuclear Regulatory Commission
1920 Norfolk Avenue
Bethesda, MD 20814

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

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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 inability 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.

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

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July 26, 1985

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WM-RES
WM Record File B-693y
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Tiktinsky
(Return to WM, 623-SS)

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

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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.