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Mr. John H. Anttonen, Assistant Manager
Office of Assistant Manager for Project
and Facility Management
Department of Energy
825 Jadwin Ave.
P. O. Box 550
Federal Building, Room 663
Richland, WA 99352

Dear Mr. Anttonen:

The NRC staff has reviewed the DOE February 23, April 1, and April 29, 1983 letters providing information on exploratory shaft construction and sealing. This material was provided in response to our letter of January 13, 1983 on the same subject.

The two fundamental questions considered in the review are: (1) are adequate provisions made to control any adverse safety-related effects from exploratory shaft construction so as to avoid compromising the long term performance capability of the repository?; and (2) is adequate site characterization data likely to be obtained from tests in the exploratory shaft? These two questions are raised early (i.e., well in advance of license application) so that DOE commitments to construction techniques can be examined thoroughly prior to implementation. They address the NRC staff concern that exploratory shaft construction and sealing does not impact site integrity in such a way as to adversely effect the isolation capability (and perhaps licensability) of the site.

As suggested in our January 13 letter, concerns about the impact of shaft construction on site integrity and information gathering can be broken down into several distinct areas: (1) shaft and seal design considerations; (2) exploratory shaft construction plans and procedures for sealing, testing, and inspecting the shaft; (3) site characterization data gathering in the exploratory shaft; and (4) quality assurance measures governing all of the above. Specific NRC concerns and comments related to the above four areas are addressed in Attachment 1. NRC consultants' comments on the DOE response are provided for your information in Attachment 2, prepared by Golder Associates, and Attachment 3, prepared by Engineers International. Attachment 4 lists the references cited in the DOE response.

WM Record File 101.2
WM Project 10
Docket No.
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In summarizing the results of our review, we note, first of all, that many plans and procedures needed for exploratory shaft construction and sealing are not complete at this time. Also, many referenced documents in the DOE response are not available for study. This necessarily limits the scope of the present review. The documents which were submitted are adequate in most respects, the exceptions being discussed in Attachment 1.

Based on the limited information provided in the DOE documents, the NRC staff has not identified any major adverse safety-related effects which will result from the exploratory shaft construction. However, in order to make a complete review regarding safety-related effects, it is the staff's opinion that the DOE should complete and submit to the NRC, as a minimum, the following key DOE reference documents: DOE references 2, 3, 4, 14, 35 and 37 (See Attachment 4). A schedule for completion of these documents is proposed in Attachment 1. This is intended to provide opportunities for timely review of plans by the NRC staff in advance of construction commitments.

If you have any questions covering the attached material, please contact John T. Greeves at (301) 427-4612.

Sincerely,

"ORIGINAL SIGNED BY"

Hubert J. Miller, Chief
Repository Projects Branch
Division of Waste Management

Attachments:
1. NRC comments on DOE response to NRC January 13, 1983 letter
2. Review of attachments to Anttonen letter, Golder Associates, Inc.
3. Comments on exploratory shaft drilling and sealing, Engineers International, Inc.
4. DOE reference documents
5. Performance of engineered barriers in a geologic repository, Golder Associates, Inc.

This technical letter was coordinated (in whole or in part) with the following staff members: M. Bell, H. Miller, J. Greeves, R. Wright, M. Logsdon, T. Verma, P. Prestholt, M. Pendleton, L. Hartung, T. Seamans, M. Nataraja, and D. Tiktinsky. Contractor input was from EI, GAI, and BDM.

~~*See previous concurrence~~

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See ltr. to Anttonen fm. Miller 11/9/83

ATTACHMENT 1

NRC COMMENTS ON DOE RESPONSE TO NRC JANUARY 13, 1983 LETTER

1) Shaft and Sealing Design Considerations

DOE states that the damaged rock zone (DRZ) created during excavation is the major effect of construction on long-term sealing capabilities. However, the reference (DOE Reference 1) used in determining effects of the exploratory shaft on the fractured rock contains only a preliminary evaluation, with assumed generic conditions, some of which are not applicable to the BWIP. For example, Reference 1 assumes an isotropic stress field, whereas a strongly anisotropic stress field is predicted at repository depth. A more detailed, site-specific analysis of construction effects is needed to build confidence that the DRZ can be characterized reliably.

It is not clear whether the seal design establishes the importance of shaft seals: for example, are six seals adequate? how are such design decisions made? We consider that a rigorous sensitivity study, using a three-dimensional groundwater flow model, is needed for the design of an adequate, shaft-seal system. Our consultants, Golder Associates, have completed some preliminary analyses for a single failure mode using a narrow range of hydrologic parameters and boundary conditions. A copy of the letter summarizing the study and its results is provided as Attachment 5. While the report points out, and the NRC agrees, that this preliminary study is a

limited analysis of the effects of shaft-seal failures, it does represent a methodology for use in the design of an adequate long-term sealing system. The use of such a methodology should be documented by DOE for our review. An adequate sensitivity analysis should consider the full range of feasible boundary conditions and hydrologic parameters and a comprehensive range of alternative failure modes. For example, the effect of a deteriorated steel liner on the seal system should be considered.

We are concerned with the effects of the short-term sealing on long-term sealing capabilities. This includes the difficulty, in a 6-foot diameter shaft, of removing, upon permanent closure of the repository, portions of the steel liner, the grout and, perhaps, the DRZ. According to the DOE response, the major impact on the DRZ is due to stress redistribution. Thus, if the steel liner and grout are removed, the rock face will be unsupported and subject to deformation. The effects of this on existing rock fractures in the DRZ needs to be assessed. The means of removing the chemical seal ring and replacing it with a long-term seal also needs to be considered. In addition, as part of assessing the effects of the short-term seals on long-term sealing capabilities, we consider it prudent that the short-term (operational) and long-term (permanent closure) sealing material program should be closely correlated. For example, most of the grout used to seal the annulus of the shaft

during its operational phase will be left in place at permanent closure. Therefore, the staff considers that it may be prudent to utilize candidate long-term sealing materials that have been developed at BWIP (RHO-BWI-C-66 and 67) or in the ONWI program (ONWI-414) as the materials for the short-term seals. Then, monitoring the performance of the seal materials during exploratory shaft operations could provide a considerable amount of information that could be useful in the design of long-term seals.

In summary, we suggest the following be considered in design plans for exploratory shaft construction:

(a) Perform sensitivity analyses to determine the relative importance of the long-term seal system on the overall repository performance.

(b) Integrate operational and long-term sealing programs of the exploratory shaft as described in ONWI-414.

(c) Identify effects of the damaged rock zone (DRZ) on seal performance and plans to characterize the DRZ.

2) <u>Exploratory Shaft Construction</u>

The construction specifications submitted to the NRC generally appear to be reasonable. However, there are still several outstanding construction documents which should be completed and made available for review prior to beginning the exploratory shaft construction. (See Attachments 2 and 3). We have these comments on the DOE's construction specifications:

(a) Drilling mud can affect hydrologic test results. Therefore, DOE should consider use of the Dual-String Circulation System as an alternative method of minimizing mud contamination of aquifers (see page 5 of attachment 3).

(b) Procedures for keying the chemical seal into the DRZ should be identified.

3) Data Gathering in the Exploratory Shaft

The DOE response does not contain adequate details on test plans for the exploratory shaft, nor was this material contained in the Site Characterization Report. Therefore, we are unable to comment on the adequacy of any such plans.

For our review, it is necessary that the test plans for the exploratory shaft and evaluation of the effects of shaft construction on the site be completed and made available, in a

timely fashion, before construction begins. We recommend that these plans be provided early on so that the staff can provide comments in a timely manner.

As identified in the January 13, 1983 NRC letter, some significant and unique information could be obtained during shaft sinking by geologic mapping of the shaft face as the repository formation is penetrated. However, this type of data gathering is precluded where the blind drilling technique is used. We recognize that there are a number of advantages obtained (e.g., minimizing disturbance, increasing worker safety, etc.) with blind drilling. However, we recommend that consideration be given to evaluating ways to examine and map the dense interior of the repository formation. We understand that there are problems associated with obtaining this information. However, there is uncertainty about how much water is present, what the hydraulic conductivities and rock strengths are, and what anomolies may exist within the basalts. Mapping the shaft wall within the dense interior portion of the selected horizon could help address these questions.

One way to obtain such information would be to blind drill and line the shaft down to the top of the dense interior of the selected horizon and complete the rest of the shaft to full depth by conventional drill and blast methods. While this is apt to be more expensive and time consuming, it does provide a unique opportunity to examine the key horizon. There may also be alternative ways to obtain this information.

We recommend that DOE document consideration of the above approach, and the alternatives, together with an analysis of the advantages and disadvantages of each.

In the area of hydrologic testing, we expect the test plans to include the following:

(a) A description of the units and intervals to be tested and of the location and orientation of portholes from which testing will be conducted. The test plan should also include a rationale for the porthole selections proposed.

(b) Methods and procedures for both hydrologic testing and analysis, taking into account space problems in the 6-foot shaft and the likely perterbations of groundwater due to shaft drilling.

(c) Methods to be used to evaluate the effects of shaft-drilling mud and lost circulation materials on hydrologic tests.

(d) Methods to be used to evaluate the effects on hydrologic tests of pressure transients induced both by construction of the shaft and by drilling of test holes.

We expect that the test plans for shaft seals will include discussions of the following:

(a) Methods to be used to characterize the damaged rock zone.

(b) Methods to be used to characterize the seal-rock bond.

(c) Effects of shaft drilling mud on sealing capabilities.

4) Quality Assurance

The quality assurance (QA) program plans submitted in the DOE response appear to be reasonable and represent a broad framework necessary for an adequate QA program. However, many of the key planning documents, such as the Exploratory Shaft test plan (DOE reference number 2), are presently not available. These types of documents should be completed prior to the beginning of an activity to ensure proper planning and exercise of control. We are concerned that the implementation of the QA program may be difficult at some levels of operation. As one example, a review of information from the RRL-2 drillhole by the NRC staff during the Geology Workshop (April 11-15, 1983) indicated that there may be some deficiencies at the filed testing level in QA procedures for core drilling and logging. Subsequently, certain drilling and logging procedures have been revised by BWIP based on input from the Corps of Engineers and

others. A well-developed and implemented QA program is necessary to help avoid problems that might result from the use of improper procedures or equipment.

Proper implementation of QA procedures can help correct situations arising from unavoidable circumstances beyond the control of the field personnel. For geotechnical investigations it is important that the QA program should prescribe qualifications for the field personnel as to their technical background and experience in the area of their responsibility. The QA program should also make allowance for providing advice from technical advisors whom the operating personnel can contact on matters involving professional judgment.

The following are additional points that the DOE should consider to adequately implement the QA program:

(a) Successful implementation of the QA program depends on efficient and accurate communication at all levels. The exploratory shaft QA plans provide for communication between the Morrison-Knudsen Co. program and the BWIP program at the executive level. In addition to this level, communication at lower organizational levels than those identified in the BWIP QA program plans is needed.

(b) Identify how the QA inspectors are prequalified for their technical background and experience in the areas of their responsibility.

(c) Periodic on site inspections by qualified peer reviewers should be considered for timely identification and resolution of QA problems similar to those encountered during drilling of the RRL-2 hole.

(d) Based on past experience (e.g., RRL-2, USBM oil shale shaft, Amchitka shaft), more detailed contingency procedures should be developed so that the project can be monitored and evaluated by QA personnel. Without this type of documentation, the site QA engineer has no recourse but to depend upon the professionalism and experience of the field personnel. This type of arrangement leaves the site QA engineer essentially powerless.

5) Completion of DOE References

The NRC staff review of the DOE response has been handicapped by the absence of significant documents. While referenced, they remain to be completed.

Based on the information needs at different stages of the exploratory shaft construction, it is suggested that the following minimum schedule be considered for completion of the outstanding references. The schedule does not take into account the minimum time needed for NRC review, which is estimated to be about one month for most documents. This is considered to be a reasonable amount of time for NRC to provide any appropriate comments on selected documents.

DOE Reference No.	Completion Schedule[1]
5, 14, 17, 26, 27, 35, 37	Prior to drilling of the 144" hole
2, 18, 28, 32	Prior to penetration of the basalt flows
3, 10, 11, 36	Prior to installation of the casing
4	Prior to installation of the grout

[1]Note: Does not include one month (minimum) needed for NRC comments.