See Pocket 7 for Ltr.

DISTRIBUTION:
WM r/f 108.4
NMSS r/f
WMEG r/f
REBrowning
MBell
JGreeves
JPearring
JLinehan
MKnapp
HMiller
JOBunting
PDR & LPDR

APR 3 1985

108.4/JP/84/12/27

WM Record File 106
WM Project 16
Docket No.
PDR ✓
LPDR ✓
Distribution:
Corr
(Return to WM, 623-SS) 13

Mr. J. O. Neff, Program Manager
Salt Repository Project Office
U.S. Department of Energy
505 King Avenue
Columbus, OH 43201

Dear Mr. Neff:

The NRC staff has reviewed both the DOE January 11, 1984 letter and the twenty-three references provided on March 14, 1984 which provide information on exploratory shaft construction and sealing. The information was provided in response to our letter of June 15, 1983.

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 June 15, 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 related to the DOE response associated with each of the above six areas are addressed in Attachment 1. NRC consultants' comments on the DOE response are provided for your information in Attachments 2, 3, 4, and 5.

After reviewing the information provided in the DOE letter of January 14, 1984, and supporting references, the NRC staff has identified concerns regarding long-term seal construction, testing, and performance. These concerns are listed below and are discussed in Attachment 1.

- A detailed program of site exploration and in situ testing of shaft wall rock is needed to support the design of operational and permanent closure shaft seals and to determine optimum location of the seals along the shaft.

*SEE PREVIOUS CONCURRENCE (INSIDE ADDRESS CHANGED ONLY)

OFC	WMEG *	WMEG *	WMRP*			
NAME	JRPearring/cj	JTGreeves	JLinehan			
DATE	4/ /85	4/ /85	4/ /85			

1031

- Operational seals and proposed permanent closure seals should be tested and monitored during the construction and operation of the exploratory shaft.

- Research efforts should include studies on the strength and elastic properties of cement based materials considered for ES shaft(s).

- Grouting plans should include detailed procedures to minimize the formation of voids in the grout, to locate the voids and to seal them.

- Procedures to detect and to rectify seepage in the shaft should include detailed procedures to ascertain the cause of seepage so that a permanent sealing method can be chosen.

- Information on the current estimate of the long-term performance of the Chemical Seal Rings should be documented.

Related to the above is the further NRC concern that the blind-hole drilling construction technique described by DOE may preclude the acquisition of adequate site information for shaft sealing. We suggest that DOE consider the following items.

- Develop plans to obtain data related to the areas of hydrology, geochemistry, and rock mechanics for the rock mass surrounding the shaft disturbed by excavation.

- Develop a quality assurance program plan for the design, fabrication, construction, and testing associated with shaft construction and sealing that satisfies the requirements of 10 CFR Part 50, Appendix B as applicable.

We regret that completing our comments sooner was delayed by higher priority work including Draft Environmental Assessment reviews. We have also recently learned from our on-site representative, Tilak Verma, that the SRPO is now planning to use the conventional drill and blast method instead of the blind hole drilling method for exploratory shaft construction. Should the DOE adopt this method of exploratory shaft construction some of our comments related to the DOE plans described in the January 1984 letter would no longer be relevant. However, most of our staff comments are applicable to shaft construction and sealing in general and therefore, are important for you to consider in your current planning. These staff comments should also be useful in planning a meeting on the exploratory shaft facility in the near future which should include discussion of those comments appropriate to your current plans. To

OFC	WMEG	WMEG					
NAME	JRPearring/cj	JTGreeves					
DATE	4/2 /85	4/ /85	4/ /85				

help us in planning this meeting with your staff, we would appreciate receiving information describing your current plans for exploratory shaft construction including available supporting references. The NRC staff suggests that an agenda for a DOE/NRC workshop be jointly developed in the near future.

If you have any questions about the attached material, please contact Jerome R. Pearring at (301) 427-4648.

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

Attachments:

1. NRC Comments on DOE ltr. of Jan. 11, 1984 and supporting ref. on Exploratory Shaft Construction and Sealing.

2. Review of attach. to DOE ltr of Jan. 11, 1984 by SNL

3. Review of attach. to DOE ltr of Jan. 11, 1984 by Dr. J. Daeman, University of Arizona.

4. Review of attach. to DOE ltr of Jan. 11, 1984 by Engineers International, Inc.

5. Review of attach. to DOE ltr of Jan. 11, 1984 by U.S. Bureau of Mines.

OFC	WMEG	WMEG					
NAME	JRPearring/cj	JTGreeves					
DATE	4/2/85	4/ /85	4/ /85				

Encl. to memo to Neff from Linehan - 4/3/85

ATTACHMENT 1

NRC Comments on DOE Letter of January 11, 1984 on

Exploratory Shaft Construction and Sealing

I. Shaft and Seal Design Considerations

A. DOE states that the potential effects of shaft construction on the shaft-wall rock mass, which could adversely affect its long term sealing capability are stress redistribution and excavation damage. Of these DOE considers the first to be more important. DOE further states that decommissioning seals can be designed to overcome the rock disturbance induced by these phenomena (DOE references 7, 9, 10).

While NRC staff concurs that these two effects identified by DOE are indeed potentially significant, the NRC staff suggests other potential phenomena that also merit consideration:

- Shaft-wall collapse such as block failures, squeezing or swelling ground, and flowing sand for all potentially susceptible formations.

- Rock mass disturbance by flushing out of filling materials from the rock when portions of the liner are removed for placement of permanent closure seals.

The references used by DOE do not appear to substantiate the conclusion that the decommissioning seals can be designed to overcome these disturbances. Rather, the references basically appear to suggest that further generic and site-specific in situ testing of seal designs is required. The requirement for research to establish bulkhead designs and the need for in situ testing and monitoring to confirm the designs are also documented elsewhere in the current literature*. The rationale for the design of bulkheads and decommissioning shaft seals need to be further substantiated.

Furthermore, the conceptual designs presented raise NRC staff concern as to the viability of the bulkhead design technique as selected by DOE. Some of these concerns are as follows:

- To key the bulkhead into the shaft wall requires more excavation which introduces further distressing that could extend and create additional leakage paths through a larger rock volume. This raises doubts as to whether the bulkheads should be keyed into the shaft walls by means of deep additional excavations.

* Auld, F.A. (1983), Design of Underground Plugs, International Journal of Mining Engineering, V.1, p. 189-228

- The length (vertical dimension) of the bulkhead should be substantial. The necessary length is governed by leakage resistance around the sides and through the surrounding rock. It is also important to recognize that the longer the length required for leakage sealing the lower the shearing or bearing stresses at the concrete to rock interface will be. These design considerations are site-specific and require in situ testing.

- The optimum location of the bulkheads is of utmost importance, and should be decided on a detailed knowledge of the geologic and hydrogeologic conditions to be encountered in the shaft. The design should allow for great flexibility to relocate or add seals as necessary to meet actual shaft conditions.

The NRC staff considers that these and other concerns about the decommissioning shaft seals can best be answered by a well planned program of in situ testing in the shaft and during subsequent monitoring.

B. DOE states that the blind-hole drilling method in itself does not reduce uncertainties in long-term sealing, but states that there are advantages to the method as follows: "In comparison to conventional drill and blast methods, it can reduce the damage caused during excavation, and supports the shaft wall through the use of weighted drilling fluids."

The NRC staff notes that reference 7 given by DOE presents several disadvantages of the blind-hole drilling method (p. 97, p. 98, p. 120), as does DOE reference 6 (p. A-4 and p. A-5), related to lack of opportunity for direct inspection and testing of the shaft wall rock. These disadvantages require consideration of additional efforts to assure that long-term sealing can be effectively accomplished.

C. DOE states that the DOE Exploratory Shaft (ES) design specifications dealing with factors affecting sealing concern only the short-term operation seals. The NRC staff recommends that the ES design specifications should also address factors related to long-term seals. Some of the seals placed at the time of ES construction will have to perform on a long-term basis. The NRC staff suggests that some permanent closure seal designs be considered for construction of short-term seals. Advantage could then be taken of the opportunity to test the permanent closure seals during in situ testing and during the operation of the repository.

D. DOE describes the mix design and materials proposed for operational and permanent closure seals. The NRC staff considers that although the

WES-PSU* developed cement materials and mix designs may have the sealing properties claimed, it has not been demonstrated that the seal systems constructed using cement materials will provide sufficient sealing for the long term time period. Industry experience with the Chemical Seal Ring (CSR) is limited to about 20 years. The DOE plan to manually place seals only at the base of the final casing does not appear to adequately consider the uncertainties associated with lack of long-term experience. The NRC staff suggests that DOE consider placing long-term seals at additional locations along the shaft.

E. DOE states that an Engineering Design Borehole (EDBH) will be drilled to obtain design and site characterization data. However, no information is presented as to the type of data that can be gathered nor is the location of the EDBH specified with respect to shaft location. It appears that DOE does not expect the EDBH to substitute for shaft-wall exposures or to provide any characterization data for the rock mass around the shaft disturbed during drilling. If the drillhole is not coaxial with the future exploratory shaft, methods for sealing the EDBH should also be addressed.

In view of the limited data to be gathered, the NRC staff suggests that DOE consider testing the permanent closure seal components in the exploratory shaft (as explained in paragraph "C" above).

II. Construction Plans and Procedures

A. DOE indicates that acceptance criteria for construction of exploratory shafts will be developed in late FY 84 or early FY 85. These criteria should address the requirements of 10 CFR 60.10 d(1) "to limit adverse effects on the long-term performance of the geologic repository" due to the shaft construction. Reference 8 does address these requirements, but only to the extent of making very broad recommendations. The NRC staff suggests that the acceptance criteria under development specifically address these requirements.

B. DOE states that damage to the rock mass can be minimized by the use of multiple liners and a controlled mud program. The NRC staff

* U.S. Army Engineer Waterways Experiment Station (WES) - Pennsylvania State University Materials Research (PSU)

recognizes the difficulties in maintaining an optimum mud density throughout the shaft sinking process, so as to prevent shaft-wall failure on the one hand and prevent hydrofracturing on the other. Mud records may not always be able to indicate occurrence of hydrofracturing. In large diameter shafts, large block failures may also occur. Oil well drilling experience with small diameter holes may not be fully indicative of all types of failure modes significant to the protection of the isolation capability of the site. The NRC staff therefore recommends that in addition to taking all possible precautions to prevent strata damage, the DOE also plans on developing procedures to mitigate damage that might occur.

C. DOE states that multiple liners have been designed for use at various proposed sites. The NRC staff recognizes that since multiple liners are planned, considerable attention needs to be devoted to complete grouting behind the liners to minimize the size and number of voids. It is therefore suggested that the methods that are planned to locate and describe any voids behind the steel lining be documented in detail along with the procedures planned to adequately seal them.

The NRC staff is also concerned about seal problems associated with mud contamination of the shaft walls and the surrounding rock mass, and of mud contamination of the cement grout. It is suggested that DOE address considerations affecting mud contamination and seal performance and document how the proper, precise locations for placement of the Chemical Seal Rings (CSRs) behind the steel lining will be determined when placing the CSRs at the aquifer/aquatard and fresh water/brine interfaces.

III. <u>Sealing and Grouting Plans and Procedures</u>

A. DOE indicates that discussions of long-term seal performance are given in DOE references (7, 13, and 14). However, the documents do not give any research plans for work on mortars and concretes needed for sealing. It is suggested that the DOE consider research efforts to include studies on the strength and elastic properties of cement-based materials at elevated temperatures. Consideration should also be given to including thermal stability testing of the long-term case when the test program indicated for the CSR is conducted.

B. The DOE understands that voids in the grout may form due to limitations in using the tremmie method of placement behind the lining and indicates that these will be detected by bond logs. Because of the potential limitation of the bond log method to precisely locate all voids in the grout in areas

congested with complex arrangements of grout and vent pipes, the NRC recommends that DOE consider uncertainties related to the efficiency of the method to discriminate voids in areas containing materials of different densities. (See Section VI, Quality Assurance of Attachment 1 for additional discussion of this subject.)

C. DOE states that a major inflow of water is not a credible event. However, it must be recognized that such events have occurred (DOE Reference 7) and proper emphasis must be placed on preventing such occurrences.

The procedures presented to detect and to rectify seepage at any point in the shaft require further elaboration. Recommend that DOE address how seepage along liner-grout, pipe-grout, and rock-grout interfaces will be detected; especially between the lowest aquifer above the salt formation and the top of the repository salt unit. The NRC staff also suggests that the DOE address uncertainties related to the potential for the recurrence of the leak during the post-closure period.

IV. Construction Test Plans And Procedures

A. DOE states that test and inspection procedures used during excavation will be tailored to be compatible with the "blind-hole" drilling method. DOE has identified requirements to ensure that shaft diameter and verticality are maintained, stratigraphic information required for verification of design is obtained, and that loss zones are identified. NRC staff is in basic agreement that both direct and indirect inspection and test techniques compatible with the "blind-hole" drilling method are available to verify with sufficient precision shaft diameter and verticality. However, the NRC staff doubts that sufficiently precise stratigraphic information can be obtained using the methods identified by DOE as compatible with "blind-hole" drilling for verification of shaft and sealing design parameters. In particular, NRC staff has considerable doubt about the precision of the visual inspection of drill cuttings for confirmation of formation composition or for confirmation of anticipated performance even when supplemented with the other drilling data identified by DOE. NRC staff recommends that DOE consider alternate ways of obtaining information such as hydraulic conductivities, geochemical characteristics, rock mass strength, and characteristics of anomalies which may exist and document their consideration of alternate methods. It is also recommeded that the DOE address uncertainties in predicting wall characteristics using these methods compared to conventional methods available when using other construction techniques.

B. DOE states that since the steel liner is designed to take the structural loads, the mechanical properties of the cement grout are not significant. The NRC staff considers that although the liner can be designed to take structural loads, it is essential that the cement grout possess adequate strength to resist failure induced by all possible static and dynamic loading conditions as failure of the cement could provide a path for water flow. If any pipes are embedded in this grout, the problem becomes even more acute, since these act as stress raisers.*

The NRC staff recommends that the DOE address current estimates of the long-term performance capabilities of the CSR materials. The NRC staff recognizes the proprietary nature of the chemical, but nevertheless would appreciate the opportunity to review all relevant data. It is suggested that DOE consider placement of the manual long-term CSRs at several horizons, and not only at a location near the bottom of the shaft above the repository horizon.

C. DOE has stated that test and inspection procedures to be used after sealing of the shaft will be developed as part of the final design effort. The NRC staff recommends that the DOE also address the specific remedial action to be taken if the test and inspection indicates grouting discrepancies.

D. DOE states that a Quality Assurance Program Plan and Manuals will identify management system requirements to satisfy anticipated licensing documentation needs, i.e., ANSI/ASME NOA-1. DOE also states that procedures will be progressively developed as definitive information becomes available by design documents and by site selection.

The NRC staff notes that the quality assurance program to be applied to the design, fabrication, construction, and testing should satisfy 10 CFR, Part 50, Appendix B as applicable. Information pertaining to the managerial and administrative controls to be used should be included in the QA program.

* Jeffery, Robert G., (1980) Topical Report, Shaft or Borehole Plug-Rock Mechanical Iteraction, University of Arizona, Department of Mining and Geological Engineering, NRC Contract No. 04-78-271

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

DOE states that it is their intention to obtain equivalent geologic information from sources other than the shafts. However, no specific plan is presented. It is suggested that the DOE address how specific geologic and rock characteristics data important to sealing will be obtained. Proposed sources for such data as rock characterization of shaft walls (e.g., shaft wall rock mass characteristics and permeability; spacing, frequency, continuity, and aperture of vertical joints) and groundwater inflow, and geochemistry should be identified. The NRC staff also considers it desirable to obtain a full suite of conventional logs from the ES prior to floating in the liner because drill penetration rates and cuttings provide only limited information.

The DOE should also consider gathering data related to the capability of the site to accept the proposed grout and to the method for placing grout for sealing.

VI. Quality Assurance (QA)

DOE identifies the line of responsibility for implementing QA procedures down to and including the Construction Manager. DOE also identifies the procedures to be used. Remedial action plans are not addressed.

The NRC staff recommends that, among others, remedial action planning for the following shaft construction and sealing matters are sufficiently important to receive special quality assurance consideration:

- Any voids in the grout behind the shaft lining need to be detected, their effect on the shaft and seal integrity assessed, and remedial action taken. DOE states that "very large" voids will be treated remedially. The NRC staff recommends a remedial action plan be developed to include a description of how voids will be positively located and a description of the method(s) proposed to adequately seal them. Information should be presented regarding what performance assessment techniques will be used to ascertain the void size below which no remedial action is required.

- Remedial action if shaft diameter is not maintained during construction should be described.

- The NRC staff is concerned about the potential for mud contamination of the shaft walls, and surrounding rock mass which could lead to mud

contamination of the cement grout. The drilling mud can affect the quality of bondage between the cement grout and the rock of the shaft walls. The mud can fill the voids in the surrounding rock and prevent an adequate seal by cement grout. The NRC staff recommend that DOE provide a description of the methods proposed for use in controlling mud contamination and a description of the remedial action proposed should mud contamination occur.

A discussion of the Geotechnical Quality Control Program for the design and construction phases of the exploratory shaft construction and sealing should be presented in the Quality Assurance Program. Areas to be addressed should include the 18 criteria of Appendix B, Part 50. Emphasis should be placed on the geotechnical engineering parameters that are significant in design, items to be controlled during construction, methods of testing, and frequency of testing. Verification efforts should insure that the design site characteristics and soil and rock engineering properties are met or exceeded during the construction phase. Remedial action planning and timeliness of corrective actions as appropriate should be also addressed in the QA program.

VII. Summary

In summary, the following NRC observations, as represented in the above material are presented:

- A detailed program of site exploration and in situ testing of shaft wall rock is needed to support the design of operational and permanent closure shaft seals and to determine optimum location of the seals along the shaft.

- Operational seals and proposed permanent closure seals should be tested and monitored during the construction and operation of the exploratory shaft.

- Research efforts should include studies on the strength and elastic properties of cement based materials considered for ES shaft(s).

- Grouting plans should include detailed procedures to minimize the formation of voids in the grout, to locate the voids and to seal them.

- Procedures to detect and to rectify seepage in the shaft should include detailed procedures to ascertain the cause of seepage so that a permanent sealing method can be chosen.

- Information on the current estimate of the long-term performance of the Chemical Seal Rings should be documented.

The NRC staff is also concerned that the blind-hole drilling construction technique described by DOE may preclude the acquisition of adequate information for shaft sealing. We suggest that DOE consider the following items.

- Develop plans to obtain data related to the areas of hydrology, geochemistry and rock mechanics for the rock mass surrounding the shaft disturbed by excavation.

- Develop a quality assurance program plan for the design, fabrication, construction and testing associated with shaft construction and sealing that satisfies 10 CFR Part 50, Appendix B as applicable.

Attachment 2.

Sandia National Laboratories
Albuquerque, New Mexico 87185

date: May 30, 1984

to: U.S. Nuclear Regulatory Commission, WMEG
Attention: Jerome Pearring

from: Krishan Wahi, Sandia National Laboratories

subject: Comments on Letter of January 11, 1984 (and its attachment) from J. O. Neff NWTS, DOE to H. Miller, HLW Technical Development Branch, NRC

A. Cover Letter

The cover letter makes two strong assumptions which may or may not be substantiated. One, it states that the decommissioning seals can be placed in the repository shafts regardless of the method of construction. Two, surface based testing programs can provide the necessary data on the stratigraphy and hydrology of the site. The ability to characterize the stratigraphy and the hydrology by means other than the exploratory shaft (ES) is necessarily limited by the size of the exploratory boreholes. Therefore, the degree of extrapolation required is much higher if the opportunity of gathering geohydrologic data in the ES is not utilized. The criteria for removing "critical" sections of the shaft liner are not described either in the cover letter or the attached response (dated 11/22/83).

B. Response to NRC Letter of June 15, 1983 (11/22/83)

- Item 3 in Section I-A appears to be a reference to the generally lower strength at reduced confining stress for several rock types. However, it is not clear as to what is meant by "loosening of the crystal structure."

- Under Section I-C, the assertion that "the ES design specifications dealing with factors affecting sealing concern the short-term operation seals" is based on a DOE decision to arbitrarily dissociate short-term sealing from long-term sealing. In reality, some of the seals placed at the time of ES construction would have to perform on a long-term basis. Also, the activities associated with the placement of short-term seals must take into account the potential long-term implications. As such, the ES design specifications should address the long-term decommissioning seals as well.

- Section I-E states that the decommissioning seal components will not be tested in the ES. This is unfortunate because a reliable data base could be established by including such testing in the ES design specifications. Since the long-term seals would presumably perform at least as well as the short term seals, why not use the mix-design envisioned for the long-term seals in the fabrication of some of the short-term seals?

- In section II-B under Prevention of Hydrofracturing, reference is made to visual inspection of the uncased salt section above the target horizon. If this is during the construction of ES, then there is a contradiction with previous statements and the proposed construction method.

- With respect to the strength and elastic properties of cement-based materials (III-A) what data, if any, have been obtained at elevated temperatures?

- The statement in the last paragraph on p. 13 (IV-B) about the mechanical properties (strength) of the cement grout being "not significant" is incorrect. Moreover, if sections of the liner are removed (as planned) and some of the cement grout fails (because of low strength) around the remaining liner, a potential for liner shift exists that could adversely affect the overall sealing capability of the system.

Attachment 3.

TO: U.S. Nuclear Regulatory Commission, WMEG 5-09-84
ATTN: Jerome Pearring
FROM: J. Daemen JD
RE: Information considered Necessary Regarding Exploratory Shaft Construction and Sealing. Letter of January 11, 1984 from J. O. Neff, NWTS, to H. Miller, HLW Technical Development Branch.

Review Summary

The letter and its attachment respond to the two main concerns expressed previously by NRC, namely that

- site characterization activities, including exploratory shaft construction, should not compromise long-term isolation and containment capabilities of the repository
- construction procedures used for the exploratory shaft will not preclude the acquisition of adequate information for site characterization

The first of these two broad concerns is raised in order to draw attention to the need to comply with 10 CFR Part 60, §60.10.d.(1); §60.11.(a), (6),(iii); §60.31,(a),(1),(iv); §60.134; §60.140,(a),(2),(c),(d),(1),(2).*

The second of these two broad concerns is raised in order to draw attention to the need to comply with site characterization requirements, e.g. 10CFR Part 60, §60.122,(b),(2),(i),(ii),(iii); (c),20; §60.140,(d),(2), §60.141,(a),(b),(c),(d).*

With respect to the first of these two broad concerns, the letter and its attachment heavily rely on references, hence the adequacy of the DOE response can only be assessed on the basis of a detailed assessment of these references. (Some of these are quite long, and a detailed critical review would be very time consuming). The DOE position on sealing presented in the letter and its attachment is that sealing problems essentially have been solved. This is in direct contradiction with conclusions reached and comments made in several of the references. The present review concentrates on identifying some of these contradictions, rather than on identifying remaining problems, because a list of such contradictions between the letter (with attachment) and the references cited in support clarifies many inadequacies in the letter. Of prime concern in this context is that many of the references identify remaining uncertainties, problems, research and testing needs on sealing performance, while the letter appears to take the position that all sealing issues are resolved and require no further feasibility demonstrations.

With regard to the second of the two concerns, the position taken in the letter and its attachment is that the shaft is used only to gain access to the

---

*All these sections of the rule appear to be relevant, but it would be desirable for NRC staff to confirm or to disavow, as appropriate.

~~8409060303 7pp~~

potential repository level, and has no other site characterization function. None of the other site characterization methods that are given can provide geological or geotechnical characterizations equivalent to shaft mapping and instrumentation. Hence not using the exploratory shaft for site characterization will result in an information gap that can not be filled by indirect or borehole methods.

Review of the letter

The subject letter was written in response to the June 15, 1983 NRC letter expressing two broad areas of concern regarding exploratory shaft construction and sealing. No new information or analysis is given in the letter nor in its attachment, which refer extensively to other documents. At first glance this suggests that the letter and its attachment are based on these references. In fact, although the references are listed, they are used only very loosely, leaving it largely to NRC to identify, from a large body of material, those items of direct relevance to the expressed NRC concerns.

Although no new information is given, the letter clarifies the DOE position considerably. Essentially the position appears to be that the references contain the information needed to close both broad concerns. No indication is given that DOE would consider an active in situ seal performance testing program (in direct contradiction with recommendations made in several of the references used in the attachment), and that no site characterization or exploratory functions will be assigned to the so called "exploratory" shaft. It might have been preferable to call these shafts "repository horizon access shafts," or some similar nomenclature avoiding the implication that these shafts would have a major exploratory function during site characterization.

With respect to the first of the broad concerns, the letter stresses short-term failure of the shaft due principally to water inflow. The short-term is strongly emphasized in this context, and the short-term presumably implies the operational phase, i.e. the period up to permanent closure, after which the entire function of preventing water inflow is assigned to the permanent seals.

By usual salt mining standards the period up to permanent closure would not be considered short-term. There is considerable evidence that over such a period of time mine shafts have leaked, occasionally with disastrous consequences (e.g. Reference 7, Section 3.2.2). Conversely, shafts of 80 years old, obviously without the CSR seal, are known that have remained dry. Twenty years of experience, as cited here, clearly is short even in terms of the construction, operation and retrieval life of a repository. No indication is given here that sealing studies will be made or are even considered in order to provide the information needed to make adequate predictions of short-term (i.e. until permanent closure) sealing performance. This is regrettable because these operational seals, especially liners and grout, could make a substantial contribution to permanent closure sealing as well as to operational sealing. The contribution of the operational seals is more valuable in direct

proportion to the uncertainties associated with the permanent seals, to which DOE apparently intends to assign the exclusive burden of permanent closure sealing.

At present, considerable uncertainty remains about the permanent closure seals as designed in reference 9, quoted in the attachment as figures 4 and 5. Reference 8 addresses decommissioning seals on p. 33, and states "methods for decommissioning underground chambers and the shaft have not yet been determined." In situ testing goals listed in pp. 1-2 include (last bullet): "Demonstration of the capability to adequately seal penetrations into the salt. This would include confirmation of the placement equipment and sealing materials." On p. 8 Reference 8 refers to reference 7 in stating "Prevention of ground-water inflow by the shaft liner and seals is of critical importance to the exploratory shaft. ONWI-255 (D'Appolonia, 1981) should be utilized for guidance. The exploratory shaft shall be essentially watertight." This complete citation of the full extent to which reference 8 addresses long-term decommissioning seals makes clear that this document states unambiguously the importance of sealing, but does not go beyond a broad statement of intent. Reference 6 makes it clear that some data needs for permanent closure seal design will remain unsatisfied due to time pressure, pp. A-4/5 in particular: "The Exploratory Shaft will be designed and constructed with licensability provisions to be used during the repository operation, but selection of horizons for final repository closure seals was not considered to carry sufficient weight to justify missing of the legislatively-mandated shaft completion milestone." Of serious concern in reference 6 are the first two sentences of section 2.2 of the Appendix, p. A-6: "The confidence based upon the sealing design and past performance of similar seals is such that special testing is not considered requisite. Proof of performance will be immediately provided when the base of the shaft liner is drilled out, and the shaft does not fill with water." Obviously, if the shaft were to fill with water immediately this would be a serious problem. If the shaft does not immediately fill with water, the opposite does not necessarily follow, i.e. this would not prove satisfactory sealing. Specific counter-examples are give in reference 7, especially section 3.2.3.2. In particular, it is highly probable that inflows would result from gradual dissolution of salt, and would develop slowly. Although it is true that considerable evidence of satsifactory performance exists, there also is significant evidence of unsatisfacotry performance, and reference 7 provides extensive summaries of both types of situations. The gas testing described would be a valuable test for the bottom seal, although only a short-term one, i.e. not providing any information about slow water ingress to the salt horizon. The main conclusion from reference 6, with regard to the effect of the particular shaft construction method (i.e. blind boring) on post-closure sealing is that several major information needs can not be satisfied because of the use of this method.

It almost certainly is true that the prime function of the shaft permanent closure seals is to prevent ingress of water to the repository salt horizon. It might be true that these seals can be placed regardless of the shaft construction method, but it is highly improbable that the sealing performance

that can be achieved will be independent of the shaft construction method. First and foremost, the shaft construction method selected (i.e. blind boring) might not allow an optimum selection of the seal position (as explicitly recognized in reference 6, section 1.3, p. A-4; reference 7, p. 98, top paragraph: " . . . there would be no direct inspection of the host rock in the shaft walls, in key areas in the aquifers above the salt and in the top of the salt section, . . . ", second paragraph: "It is not advisable that all shafts at a site be drilled and lined blind," (similar comments in many other places).

It is highly unlikely that the proposed over-excavation of the shaft will mitigate the effects of rock damage caused by liner removal. Such over-excavation will, with some shaft sinking methods (e.g. boring with mud-filled shaft) for the first time, relieve the stress on the newly exposed surfaces, precisely at those locations where permanent seals are to be installed. This would at least partially negate one of the principal advantages of blind boring with a mud-filled hole, namely that the shaft walls are never entirely stress relieved (and therefore maintain maximum possible integrity). This might affect not only the rock adjacent to the seal, but also the liner-grout-rock system directly above and below the seal as well.

Even the title of reference 9 emphasizes the preliminary nature of this study, which unquestionably is a significnat step in the right direction, but is probably more important in terms of the procedures it outlines for future studies and site-specific designs rather than for specific applications and conclusions. Many examples of uncertainty can be found in this document, e.g., p. 121, first sentence of last paragraph: "Additional study is required to determine the effectiveness of bulk-heads for reducing disturbed zone permeabilities." Of particular concern in this context is that neither reference 9, nor, to the best of my knowledge, any of the other references addresses the potentially serious sealing problems associated with extensive shaft sloughing in the weak rocks above the salt formations. The high probability of such sloughing is indicated by the borehole stability problems encountered in the Permian Basin, as noted in the attachment (p. 7, II. B) and in reference 6(p. A-8).

None of the alternative site characterization methods that are given can provide the type of information and certainly not the detail and quality of information that would be available through direct physical access to the shaft wall. This is stated unambiguously in reference 6, Section 1, especially pp. A-4/5, in reference 7 in several places, e.g., p. 98, p. 104: "Disturbed zone and host rock-seal interface characteristics which are critical to adequate seal performance, are not routinely obtained from site characterization," p. 120, next to last paragraph: "An associated disadvantage is that . . . there is no possibility for direct visual inspection of the host rock or placement of water seals."

It might well be that the method of exploratory shaft construction can accommodate the techniques being considered for shaft decommissioning sealing. No indication is given that the acceptability of the techniques being considered will be tested. Given the considerable uncertainty about the performance

of the permanent closure seals, to which the full responsibility for long term repository sealing is assigned, it must be considered a serious deficiency that no more effort is made to assess the performance of the operational seals. It appears probable that a significant long-term sealing function could be assigned to operational "seals" (especially grout), and that uncertainty about the effectiveness of the rock surrounding the shaft in reducing or preventing water flow towards repository formation salt could be reduced, if an adequate in situ testing program could be incorporated into the Exploratory Shaft functions. This in turn would reduce the need for making assumptions when making performance assessments.

Review of Attachment

Time does not permit a very detailed assessment of this document, which relies heavily on references, some of which have only recently become available to me. Emphasized below are some very clear contradictions between positions taken in this attachment and conclusions or recommendations reached in the reference documents. Such contradictions are stressed because it appears that the technical references make recommendations that would come much closer to meeting the NRC information needs than does the DOE letter and attachment. The main point of contention might well be when, as much as whether, sealing information is needed, the DOE position being that ES construction has no impact, hence should not presently be of concern.

I.A. The conclusion that the seals can be designed to overcome these disturbances can not be drawn from references 7, 9, and 10, all of which identify signficant remaining uncertainties in seal design. Reading of several sections should make this obvious. Chapter 5 of reference 7 identifies numerous parameters that are essentially unknown, and recommends generic and site-specific testing. (Particularly section 5.2, lists on p. 105, 106; p. 106: " . . . very little is known regarding the nature or extent of the disturbed zone for a given combination of rock type and excavation process"). Reference 9, p. 82: " . . . there is probably no practical means for restoring the permeability throughout the disturbed zone to that of the undisturbed rock." Reference 10, p. 4: "Preliminary designs will incorporate site and penetration characteristics obtained from shafts and tunnels at the candidate repository site and will be supported by in situ testing of seals or seal components. Preliminary designs will be sufficiently complete and detailed to be submitted to the regulatory authority as part of a license application for repository construction."

The emphasis in the attachment is distinctly different from that in the reference it quotes. The latter clearly expresses the need for further study and demonstration, including site specific in situ testing (as well as generic work), and specifically acknowledge areas of uncertainty not recognized in either the letter or the attachment.

I.B. The statement that the selected excavation technique does not in itself limit uncertainties in the consideration for long-term sealing certainly is true. It is more difficult to accept the last sentence, that shaft design

does not preclude the effectiveness of decommissioning seals to reduce the associated uncertainties, in light of several statements in reference 7, e.g. p. 98, first three paragraphs, p. 120, A.1.2, second paragraph: "An associated disadvantage, however, is that . . .", p. 53, 2.6, last sentence of first paragraph, p. 92, last sentence of first bullet, in reference 6, e.g. pp. A-4/5.

The long term post closure seals described here appear to include the backfill inbetween the bulkheads. A major uncertainty remains in this area, namely whether or not the liner will be removed. This remains unclear, especially for backfill sections inbetween bulkheads. The design figures, especially figure 3, emphasize backfill compatible with the surrounding rock, as does reference 10, yet the emphasis that the liner will removed at bulkhead locations sometimes appear to imply that these are the only locations where the liner will be removed. The performance assessments (references 13, 14) clearly imply that the liner (and grout) will be removed over the entire length. A clarification of this issue is needed.

Particularly for a steel liner in a salt (brine) environment leaving it in place could have significant implications, that need to be addressed.

I.E. No characterization of disturbed zone.

No seal testing data for License Application.

II.A. Reference 8 does address the 10CFR60 Subpart B §60.10 d(1) requirements "to limit adverse effects on the long-term performance of the geologic repository" only to the extent of very broad recommendations.

II.B. Response addresses two (important) aspects: preventing collapse and preventing hydraulic fracturing. Does not deal with damage due to stress relief if it is not severe enough to cause collapse.

What remedial action will be taken if localized or substantial shaft collapse does take place during drilling, and how would it affect operational or permanent sealing?

How will the mud engineer know that the mud pressure never exceeded the minimum principal stress? (i.e. how does the mud engineer know the minimum principal stress?)

II.C. Problem of mud contamination on walls and in cement, widely recognized as a serious difficulty in oil well cementing, is not addressed at all.

III.A. Except for a vague test program on CSR material, no reference made to extensive further research needs identified in references. No indication of further test plans.

III.B. A more detailed analysis is needed of the probability of successful void detection by means of cement bond logs only, given the complex arrangement of pipes through the cement grout.

How will adjacent stratigraphy be determined? Problems with over-excavation have been discussed earlier, in comments on letter.

III.C. How will seepage along liner-grout, pipe-grout, rock-grout interfaces be detected, especially between the lowest aquifer above the salt formation and the top of the repository salt horizon?

It might well be that a sudden major inundation of the shaft is not a credible event, according to reference 6, but it must be recognized that inundations of salt shafts have happened (reference 7).

IV.A. What will be the remedial action if shaft diameter is not maintained?

It is somewhat surprising that no water inflow limits are included under the acceptance criteria.

IV.B. It clearly is not true that the mechanical properties (strength) of the cement grout are not significant. Some structural loads (primarily rock pressure) must be transmitted through the cement to the shaft liner casing. If the cement fractures during this load transmittal, the resulting (almost certrainly vertical) fractures could become a high permeability water flow path. This problem could become particularly severe for those shaft liner designs that call for multiple utility pipes outside the liner, embedded in the grout. Each pipe could act as a stress raiser. If high stresses are thus generated (e.g. due to salt creep) it is easily visualized that grout cracking could result: (Detailed discussions of such problems are given in the topical report by Jeffrey, University of Arizona, 1980, to NRC).

IV.C. Is any remedial action planned if bond logs reveal low density cement?

V.A. It would be desirable to obtain very specific information as to what other sources will be used to obtain this information, for example:

-rock characterization of shaft walls (e.g. disturbed zone permeability, vertical joint spacing, frequency, continuity, aperature.
-groundwater inflow
-shaft shape

It would seem desirable to try to run a comprehensive suite of logs prior to lining.

Excellent summaries of the gap in knowledge resulting from the decision to drill are given in reference 6 (pp. A-4/5) and in reference 7 (e.g. p. 98, 103-105).

References

All references refer to references in the attachment to the subject letter.

Attachment 4.

98 East Naperville Road
Westmont, IL 60559-1595

ENGINEERS INTERNATIONAL, INC.

Telephone: 312/963-3460
Telex: 9106511931
Cable: ENGINT

WM Record File D1004
WM Project 10,11,16
Docket No.
PDR ✓
LPDR ✓ (B,N,S)

Distribution:
Buckley
(Return to WM, 623-SS)

31 May 1984
Ref. No. 1148-003-027
Project Letter No. 027
Airborne No. 373362463

Waste Management Engineering Branch
Division of Waste Management
U. S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Spring, MD 20910

Attention: Mr. John Buckley, Project Officer
Mail Stop 623-SS

Subject: Preliminary Comments on DOE response to the 15 June 1983, NRC letter regarding Exploratory Shaft construction and sealing

Ladies and Gentlemen:

As requested in the 24-25 May Data Review Meeting, we have assembled the comments and questions of the meeting participants. These are provided below for your information, reference, and use; we understand that the draft NRC response will be sent to us for comment.

Please note that we have not, as was agreed, considered Quality Assurance aspects in detail.

Sincerely,

ENGINEERS INTERNATIONAL, INC.

Madan M. Singh
Project Manager

MMS/cgk

Enclosures

~~8411080365 11pp~~

I. SHAFT AND SEAL DESIGN CONSIDERATIONS

A. DOE indicates that shaft construction has essentially two types of major effects on the sealing capability of the shaft-wall rock mass: stress redistribution and excavation damage. Of these the first is said to be more important, and it is further stated that decommissioning seals can be designed to overcome the rock disturbance induced by these phenomena.

NRC would like to suggest that other phenomena should be considered, including shaft-wall collapse, and flushing out of filling materials from the rock mass when the liner is removed for decommissioning seal placement.

DOE's statements appear to recognize that the rock disturbance due to the presence of the excavation causes greater damage than that due to the excavation process. Would it then be fair to surmise that the only reason for selecting the blind hole drilling method is the scheduling constraints?

It should also be noted that the references quoted by DOE do not, by their overt statements or their apparent intent, suggest that blind hole drilling necessarily simplifies the construction process or insures the integrity of the site. Rather, these references recommend further generic and site specific testing. The seal designs presented in the references need to be tested in-situ (as recommended by the designers themselves) and appear to be inconsistent with some of the late principles of bulkhead design (Auld, 1983). This reference, in fact, throws some doubt on the viability of the selected bulkhead design technique. The rationale for this design should be substantiated before further development is performed.

B. DOE apparently appreciates that the blind-hole drilling method in itself does not reduce uncertainties in long-term sealing, but states that it causes less damage than blasting. This statement seems to contradict the realization in "A" above, that most of the damage is caused by stress relief, not by the method of excavation. Besides, reference "F" given by DOE itself presents several associated disadvantages (pages 53, 92, 98, 120), as does reference 6 (pages 4 and 5).

C. DOE has presented the proposed designs for the short-term operational and the decommissioning seals. However, no data are presented which demonstrate that such seals have been tested under hydraulic heads and found to hold under the anticipated thermal, mechanical, and hydraulic conditions that exist at the site. The DOE response gives no indication that an active in situ testing program will be undertaken that will verify the performance of as-built seals or the generic seal designs.

Besides, if the shaft-wall rock is not exposed, it is not clear how the aquifer/aquatard boundaries will be precisely located to adequately place the seals. It is redundant to point out that these aquifer boundaries will not be distinct. It is also clear that, in the practical sense, some of the short-term seals will also perform as long-term seals. It is suggested that some decommissioning seal designs be considered for short-term seals, to investigate their constructibility, and their performance during the operational period.

D. Although the WES-PSU developed materials and mix designs may have the sealing properties claimed, it is not demonstrated that the seal systems constructed using these substances will necessarily be leak-proof for the time periods required.

The DOE response apparently holds the position that 20 years of industrial experience with seal placement confirms the adequacy of the conceptual seal designs referred to in the letter. Has the industry experience for the CSR been gained under similar circumstances (i.e. large diameter shaft, high temperatures, surrounded by water/brines)? Is 20 years a comparable period in the context of repository design? The statement that manually placed seals will account for the uncertainties is not substantiated.

How is it intended that "compatibility" will be assured between the concrete aggregates and the adjacent stratigraphy?

E. DOE states that an EDBH will be drilled to obtain design and site characterization data. What information is expected by DOE from this source and will it be gained in time to verify design assumptions, seal placement, and so on, before irreversible construction measures are taken? The location of this hole is not indicated. Is this expected to be coaxial to the shaft or at some distance? If not coaxial, how will this hole be sealed? It appears that the EDBH will not provide any characterization of the disturbed zone.

How will the axial and radial deformations and the tilt of the drilled shaft be measured? How will the function of the piezometers intended to monitor the water pressure buildups behind the shaft be assured?

A suggestion to test long-term seal designs in the ES was made above.

II. CONSTRUCTION PLANS AND PROCEDURES

A. DOE indicates that acceptance criteria will be developed in late FY 84 or early FY 85. It cannot be overemphasized that these criteria need to address the requirements of 10CFR60

10.d(1) and that excessive damage not be caused. If the drilled shaft creates such a situation, what steps does DOE contemplate to rectify the situation? Reference 8 only presents very broad recommendations about the adverse effects on the long-term performance of the repository.

B. DOE states that damage can be minimized by the use of multiple liners and a controlled mud program. The "worst" collapse case is said by DOE to result from "flowing sand".

It is not clear how the mud density can be maintained optimally throughout the shaft sinking process, so as to prevent shaft wall collapse on the one hand and prevent hydrofracturing on the other. Mud records may not always indicate occurrences of hydrofracturing, and visual inspection will be possible only in limited areas. It should be stressed that apart from taking all possible precautions to prevent strata damage, DOE should outline reliable and thorough procedures to identify and mitigate damage that may occur. It is not clear what failure scenarios have been considered or how these have been ranked. While running ground is certainly a severe problem, in large diameter shafts, large block failures may also occur. Oil well drilling experience with small diameter holes may not be fully indicative of all types of failure modes significant to the protection of the isolation capability of the site.

DOE can only be encouraged to develop drilling controls that do not permit any adverse effects. How does DOE intend to perform the visual inspection of the uncased portion of the shaft? It is presumed that this cannot occur until after the shaft construction is completed.

C. Since multiple liners are planned to effect operational sealing, considerable attention needs to be devoted to complete grouting behind the liners. How does DOE intend to ensure that voids can be positively located behind a steel lining and in the presence of utility pipes? How will such voids be sealed and the adequacy of the sealing proved? What assurance is there that some of the grout lines will not become pinched during the liner installation, preventing thorough lining.

Attention needs to be devoted to mud contamination near the shaft-wall. The placement of the chemical seal rings must be at the aquifer/aquatard and fresh water/brine interfaces; how will these locations be positively located in the ES?

III. SEALING AND GROUTING PLANS AND PROCEDURES

A. DOE indicates that discussions of long-term seal performance are presented in the given references (7, 13, and 14). These documents do not give any research plans for obtaining such

information. DOE itself admits that only limited work has been conducted on mortars and concretes needed for sealing. It should, therefore, undertake a thorough program to perform such testing. The test program indicated for the CSR also needs to be conducted, including thermal stability for the long-term case.

B. DOE evidently appreciates the problems that voids can cause, and indicates that voids will be detected by bond logs. The adequacy of this approach in view of the complex assortment of liners and utility pipes, not to mention grout lines, needs to be assured.

How does DOE intend to determine the adjacent stratigraphy? DOE states that only "very large" voids will be treated remedially. What performance assessment techniques has DOE utilized to ascertain the void size below which no remedial action is required?

It appears that operational seals will be punctured to install the post-closure permanent seals. The construction procedure for the manually placed bulkheads needs elaboration. Further, as indicated earlier, the suggested design of the bulkheads is questionable. The thermal stability of these seals and the corrosion of any steel in the system require particular attention.

C. DOE's statement that a major inundation is not a credible event seems to dismiss such an occurrence which can arise from a variety of causes, rather casually. In fact Reference ~~8~~ 7 furnished by DOE presents several such cases.

The only occurrence mentioned as appropriate for remedial treatment is seepage. Is the absence of seepage the proof of a lack of seal inadequacy?

Further, the procedures presented to rectify seepages are only applicable to the operational period of the repository. Can remedial treatment be effected after the permanent closure? Even during the operational period, the occurrence of a seepage would indicate a failure of the as-built system and temporary stoppage with grouting, without ascertaining the cause of the seepage, would leave the potential for the recurrence of the leak during the post-closure period.

IV. CONSTRUCTION TEST PLANS AND PROCEDURES

The inspection procedures to be developed by DOE require attention. There is considerable doubt about the adequacy of the drill cuttings for obtaining concise stratigraphic information. Further, elaboration would be desirable on how DOE

intends to fully verify shaft design assumptions from drill cuttings, or even from the shaft diameter, verticality, and fluid loss data. The specifications for allowable water in flows into the shaft need to be fairly severe.

B. DOE states that since the steel liner is designed to take the structural loads, the mechanical properties of the cement grout are not significant. This is clearly not the case. Failure of the cement could produce conditions violating the design assumptions. Such fracturing would provide a permeable path. If any pipes are embedded in this grout, the problem becomes even more acute, since these act as stress raisers.

NRC would like to get more information on the CSR, as to its long-term performance. NRC recognizes the proprietary nature of the chemical, but nevertheless requires the data. How will DOE identify and control the exact horizons at which the CSR's are to be placed? How will the purity and quality of the CSR placement be assured in a blind-drilled shale. NRC would suggest that DOE consider placement of the manual long-term CSR at several horizons, not just above the repository horizon.

Prevention of contamination of the drilling mud due to the cement grout needs to be given special attention, and should be discussed.

C. DOE intends to develop test requirements and acceptance criteria as part of the final design. This reverses commonly accepted practice, since the design needs to meet these criteria.

What remedial action does DOE contemplate if the bond logs indicate a low density cement?

D. (NRC will address)

V. PLANS AND PROCEDURES FOR GATHERING SPECIFIC INFORMATION RELATED TO SITE CHARACTERIZATION

DOE intends to obtain equivalent geologic information from sources other than the shaft. What are these sources and how will this information be obtained? NRC would consider it desirable to obtain a full suite of conventional logs from the ES prior to floating in the liner.

REFERENCES

Auld, F. A. (1983), Design of Underground Plugs, Intl. Jour. Mng. Eng., v 1, p. 189-228.

ATTACHMENT 5

June 25, 1984

Memorandum

To: Earle R. Amey, III, Staff Engineer, Division of Health and Safety Technology, Mail Station 6010, Washington, DC

Through: Research Director, Spokane Research Center

From: Mining Engineer, Spokane Research Center

Subject: Review for NRC of Reports on Siting Plans for Salt Repositories, Shaft Sealing in Salt, and Quality Assurance Plans

The documents reviewed were forwarded by David Tiktinsky, NRC, by memo dated April 25, 1984. In general, we found all reports to be well written and pertinent to the problems. Specific critical comments are as follows:

ONWI-255 "Sealing Considerations for Repository Shafts in Bedded and Dome Salt," December 1981

One of the often mentioned assumptions stated in this report is that the salt will creep around the shaft and eventually seal any leakage. However, when we review all the data that has been collected over the years about past shaft histories driven in salt, we find no mention of such creep closure around a shaft. Was that very important point simply missed by field investigators? One could gain the impression that just the opposite actually happened. In many cases where leakage into the mine occurred through fractures, an obvious hydraulic pathway existed right to the surface through several hundred feet of salt.

ONWI-411 "A Preliminary Evaluation of the Rock Mass Disturbance Resulting from Shaft, Tunnel, or Borehole Excavation," November 1982

Overall, this report was well rated. We request that authors review rock salt fracturing experiments done in the 1960's under such projects as COWBOY which developed a lot of fracturing data in salt caused by high explosives. Beginning on page 93, "Recommended Methods for Disturbed Zone Investigations," reviewers have noted that pure and simple good old geologic mapping appears to be underrated. However, combined with photography, or even videotape, a complete permanent record of all underground opening surfaces could be easily obtained.

ONWI-405 "Schematic Designs for Penetration Seals for a Reference Repository in Bedded Salt," November 1982

The stated purpose of this report is to present some schematic seal designs for a repository in bedded salt only for peer review with the intention of further updating when the final site has been selected. Unfortunately, two years later we apparently have not been provided with final site selection. The report is generally consistent with the original intent and no specific comments are made. Perhaps one point can be made for further study of the clay/salt seal against the particular compatibility of the geochemistry of the invading waters.

ONWI-455 "Functional Design Criteria for the Exploratory Shaft in Salt," July 1983

Reviewers note that much of this report could be condensed into a tentative work order of no more than 10 pages. There really is design criteria for shafts in this report.

ONWI-494 "Performance Assessment of a Shaft Seal System in a HLW Repository in the Gibson Dome Area," August 1983

We cannot judge if this is a serious report or are we to accept the remarks in the Abstract and the Executive Summary as definitive in scope of work. Thus, when the report speaks of "the methodology has proven useful in reasonable estimates of some important aspects of shaft seals" and the "mathematical demonstration designed to evaluate" leaves one with an uneasy feeling about the precision of the information presented. On page 9, (assuming water is incompressible), we are dealing with an overburden of 2,000 to 5,000 feet. Then the compressibility cannot be neglected. An equation described as "highly nonlinear" speaks of another giant problem. However, the summary on pages 81-82 does realistically discuss the limitations of the calculations. That is a very honest page.

The references should at least show the books by Muskat; it would seem that many references are included to justify a specific line of analysis rather than to generalize the problem, i.e. picking references over several decades.

ONWI-493 "Conceptual Test Plan for Site Confirmation Testing at an Exploratory Shaft in Salt," September 1983

No comments on the criteria other than an apparent conflicting statement made about constructability, page 4, wherein it says the word means the impact of construction upon the repository, but on page 6, it says we are looking at construction without undue hazard to personnel. It would seem, therefore, that we have somewhat of a shift in objective. Constructability considerations are equally as important as containment simply because if we cannot construct the facility we certainly cannot speak about the guarantee of containment.

ONWI-479 "Selection and Durability of Seal Materials for a Bedded Salt Repository: Preliminary Studies," November 1983

On page iii, the statement is made that bonding studies have been made. We regret that no bonding experiments as used in the traditional concrete testing sense are reported in this document. On page 5, it would be worth noting how the samples that were collected were used in these salt experiments. For example, general practice is either to wrap or seal the salt samples to prevent degradation of cores, especially the more friable cores. And it is not noted at from which drilling depths the cores were selected. Further on page 5, item 2, at the bottom of the page, the use of mined out rock salt is considered for concrete mixtures for reasons of economy. This is an old idea from the construction industry but in practice it has been found not economical because you will have to wash, crush, screen, and resize the tunnel muck. All this additional work has been found to be expensive. We would presume the same would hold true for rock salt. On page 14, it is difficult to follow what concrete/salt mixing procedures were used and in what size the trial mix was batched. In practice, there usually is some difference when small, only a cubic foot or so, trial mixes are used and when several cubic yards are batched.

The next group of documents pertained to field test programs and quality assurance programs. General comments are as follows:

SAND79-0739 "Test Plan Bell Canyon Test WIPP Experimental Program Borehole Plugging," March 1979

This document is now 4 years old. Its purpose in this package is unknown, however, as a role model for future work no exceptions were noted. We suggest that the words "should" in many places be changed to "shall" to conform to later documentation provided in this review package. Perhaps, too, there should be reply correspondence from Fenix and Scisson commenting on the technical merits of the tasks they are assigned.

"Quality Assurance Manual, National Waste Terminal Storage Program Office," December 1982

As a general NPO Policy Statement manual for administrative personnel, this manual could fulfill such a general purpose. However, as related to quality assurance procedures in the field, this manual is sadly lacking. There are no words to convey job-site, field project tasks, drilling, mining, or any of the true functions of the National Waste Terminal Storage Program. It is suggested that the NPO, or its delegees, never really get their hands dirty with true quality assurance.

"Exploratory Shaft Facility (ESF) Project Management Plan," May 23, 1983

No specific comments are made. Perhaps on page 10, at the very bottom, the lead item should read "authorize start/stop work," and not be limited to only "stop work". All the appendices are well done.

"Salt Exploratory Shaft Construction Method," DOE Memo July 7, 1983

No comments. We concur with all issues presented.

"NPO Milestone 133H337 - Letter Report on Seal Performance Requirements to NPO," October 31, 1983

No comments. This report is a presentation of mathematical methods and formation property data pertinent to seal design. No construction considerations are given.

"Exploratory Shaft Facility Quality Assurance Program Plan," by Parsons Brinkerhoff, November 1983

This document on a quality assurance program was written by the contractor. However, again it appears that it is a management control document and we never really mention the words suggesting the true purpose. Thus on page II-4, paragraph C, specific construction items are included as notes to Quality Assurance Levels I and II, respectively. The NRC will have to come to grips with specific underground dialogue and not rely on buzz-words. There must be a few words they could use to suggest an underground mining project.

"Preparation and Implementation of Engineering Procedures," by Battelle Project Management Division, November 1983

No comments.

"Quality Assurance Program Plan, Exploratory Shaft Facility (ESF), Construction Manager," by Parsons-Redpath, no date

This document appears to be an abstract of other Quality Assurance Programs but narrowed to the scope of Parsons-Redpath. Again, we have trouble with being non-specific with regards to mining. Herein, we see that right down to the field contractors they cannot grasp the true Quality Assurance objective.

Eugene H. Skinner

cc: Skinner
[illegible] Files
SC—General:Skinner:lrn:6-22-84