see pocket for enclosure

WM DOCKET CONTROL CENTER

'84 JAN 16 P4:57

Department of Energy
National Waste Terminal
Storage Program Office
505 King Avenue
Columbus, Ohio 43201

January 11, 1984

WM Record File 106
WM Project 16
Docket No.
PDR ✓
LPDR ✓
Distribution:
HM
(Return to WM, 623-SS) C2

Hubert Miller, Chief
HLW Technical Development Branch
Division of Waste Management, MS 623-SS
Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, MD 20910

Dear Mr. Miller:

INFORMATION CONSIDERED NECESSARY REGARDING EXPLORATORY SHAFT CONSTRUCTION AND SEALING

Your letter of June 15, 1983, has expressed two broad areas of concern regarding exploratory shaft construction and sealing:

- "That the site characterization activities, i.e., constructing an exploratory shaft, will not compromise subsequent long-term isolation and containment capabilities of the repository, and

- "That plans for construction of the exploratory shaft will not preclude the acquisition of adequate information for site characterization."

With respect to the first of these two broad concerns, and as far as the design and construction of the exploratory shaft is concerned, the site may be compromised either by:

- Failure of the shaft in the short-term due principally to water inflow, thereby causing severe damage to salt at the proposed repository horizon, or

- Use of a construction method which would preclude the placement of an effective long-term sealing in the shaft at the time of decommissioning and closure of the repository.

In order to prevent a short-term shaft failure due to ground water inflow, the shaft has been designed with multiple casings and operational seals (References 1, 2 of attachment). The primary function of these casings and seals are to prevent shaft failure caused by water inflow between the liner and the shaft wall. Seal material and method of placement of these seals (both remote and by hand) are selected based on 20 years of demonstrated experience and capability of these sealing materials to prevent ground water inflow (References 3, 4, 5).

220

encl. to ltr. dtd. 10/1/87

WM Record File 106

WM Project 16

Docket No. ______

PDR ✓

X LPDR ✓ (5)

Distribution:

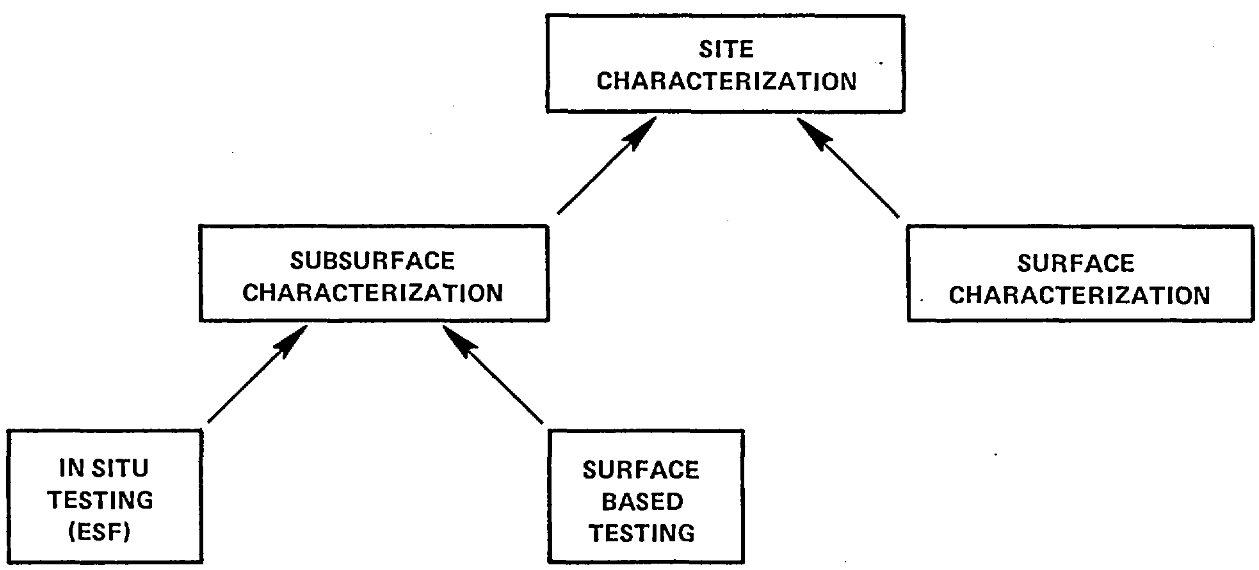
Linehan | Youngblood
Galson | Bilhorn

(Return to WM, 623-SS)

1688

The use of a particular shaft construction method, and its effect on the future installation of the long-term decommissioning seals have been addressed in various documents (References 6, 7, 8). The primary function of the shaft decommissioning seals is to prevent the flow of water from overlying aquifers into the repository. These seals can be placed in the repository shafts regardless of the method of construction of the original shaft, since decommissioning may require that critical sections of the shaft liner be removed. The decommissioning shaft seal designs incorporate manually constructed bulkheads that are "keyed" into over-excavated sections of the shaft wall. Over-excavation of the shaft wall will mitigate the effects of rock damage caused by liner removal and the physical degradation cause by the stress relief over the operational time (Reference 9).

With regard to the second of the two concerns, it should be noted that the salt site characterization program consists of many elements, as depicted in the following figure.



The in situ testing, to be conducted using the exploratory shaft as an access to the proposed repository horizon, is only a small portion of site characterization program. The exploratory shaft itself does not have the function of acquiring data on overlying rock strata. Instead, data on these strata, including hydrological data, will be obtained by surface-based testing programs, such as exploratory drilling, hydrological tests, and geophysical methods. Therefore, the method of exploratory shaft construction does not affect the site characterization activities and can accommodate the techniques being considered for shaft decommissioning sealing as part of repository closure.

The Architect-Engineer has completed the preliminary designs for the exploratory shaft and at present is working on the final design for those ES components that are common among the sites and is delaying the final design for those componenets that require site specific design information. The A/E will revisit the final designs when the data from Engineering Design Bore Hole (EDBH) becomes available and make revisions to the drawings, as necessary, prior to start of shaft construction.

With the above description and clarification in mind, we have prepared the attached reponse to answer each of the six fundamental questions raised in your June 15, 1983 letter:

- Shaft and seal design considerations
- Construction plans and procedures
- Sealing and grouting plans and procedures
- Construction testing and inspection plans and procedures
- Plans and procedures for gathering specific information related to site characterization.
- Quality Assurance

If you need any of the cited references and they are not in your library, please write us a letter requesting those you need.

We have compiled this response to answer specific questions raised in your June letter. Our intent is to meet with you in the near future to continue the discussions on the issues of concern to you. Should you have further questions on this matter do not hesitate to contact me.

Sincerely,

J.O. Neff

J.O. Neff
Program Manager
NWTS Program Manager

NPO:RCW:kgh

Enclosure:
11/22/83 Response to NRC letter of June 15, 1983 on the subject of Exploratory Shaft Construction and Sealing.

cc: W. Bennett, DOE-HQ, w/enclosure
M. Frei, DOE-HQ, w/enclosure
R. Johnson, NRC, w/enclosure
J. Greeves, NRC, w/enclosure
R. Forsythe, MS, w/enclosure
S. Frishman, TX, w/enclosure
H. Bohlinger, LA, w/enclosure
J. Christofferson, UT, w/enclosure

ST# 133-84

see ltr. to Miller fm Neff 1/11/84

11/22/83

RESPONSE TO NRC LETTER OF JUNE 15, 1983 ON THE SUBJECT OF EXPLORATORY SHAFT CONSTRUCTION AND SEALING

I. SHAFT AND SEAL DESIGN CONSIDERATIONS

A. Provide an analysis of the potential effects of construction of the exploratory shaft on long-term sealing capabilities of rock mass and identify factors that determine the nature and extent of such effects.

The potential effects of shaft construction on the long-term sealing capabilities of the shaft-wall rock mass are:

- stress redistribution
- damage by excavation

Of these, stress redistribution is the likely phenomenon to cause the most pronounced effects. Disturbance in the rock mass might then arise in one of three ways resulting from the redistribution:

1. by fracturing of orginally intact rock due to excessive compressive or tensile stresses,

2. by opening or closing of pre-existing fractures due to changes in the normal stresses acting across the fractures or to shearing stresses along the fractures,

3. by loosening of the crystal structure in response to reduced confining stresses (particularly in salt).

We have conducted studies of these effects, and have concluded that the decommissioning seals can be designed to overcome these disturbances (References 7, 9, 10).

B. Describe how the selected excavation technique and shaft design accounts for limitations and uncertainties in long-term sealing considerations.

The selected excavation technique (large hole blind drilling) does not in itself limit uncertainties in the considerations for long-term (shaft) sealing. 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. As discussed previously, the shaft design has been examined to assure that it does not preclude the effectiveness of decommissioning seals to reduce the associated uncertainties (References 7, 9).

C. Provide design specifications for the shaft construction and show how they deal with factors affecting sealing.

The ES design specifications dealing with factors affecting sealing concern the short-term operational seals. For example, the design for the Permian Basin shaft calls for remotely placed chemical seal rings and oil field type grout seals, and a final manually placed operational seal. Figure 1 shows the location of the oil-field type grout seals and chemical seal rings (Reference 1). The details for the manually placed seal are shown in Figure 2 (Reference 1).

D. Describe the seal design and materials.

Operational Seals

The shaft operational seal design (References 1, 2) calls for the placement of salt saturated expanding cement between the casing and the shaft-wall and chemical seal ring (CSR) at the bottom of each casing set.

Work at the Waterways Experiment Station (WES) and the Pennsylvania State University Materials Research Laboratory (PSU) on borehole sealing formulation show that salt-containing cements have low permeability, good bond strength, and are generally suited for this intended use (Reference 11). The mix design will be based on the formulations such as BCT-1F developed by PSU and WES, and will include the following components:

- Class H oil well cement
- Silica, dolomite, anhydrite and halite aggregate
- Pozzolan
- Water-reducing and set-retarding admixtures
- Mix water containing chloride ion
- Expansive admixture (if expansive cement is not used)

The CSR developed by Dowell Division of Dow Chemical Company (References 3, 4, 5) consists of a dispersion of a water-sensitive, high-molecular-weight polymer in a hygroscopic organic liquid (glycerine and glycol mixture). A water soluble chromium compound crosslinks the polymer dispersion. The CSR promises an operational life of at least 20 years based on industry experience. (Reference 4).

Manually placed seals, at the base of the final casing, will account for the uncertainties in the performance of the oil field type seals and the CSR.

Decommissioning Seals

The long term decommissioning shaft seals include multiple components (References 7, 10). As shown in Figures 3 and 4, there are: three types of "bulkhead seals"; three types of backfill material between the bulkhead seals; and top and bottom structures. The bulkheads constructed of concrete will use mix designs based on PSU and WES formulations developed for borehole sealing (Reference 11). Aggregates used in the concrete will be compatible with the adjacent stratigraphy.

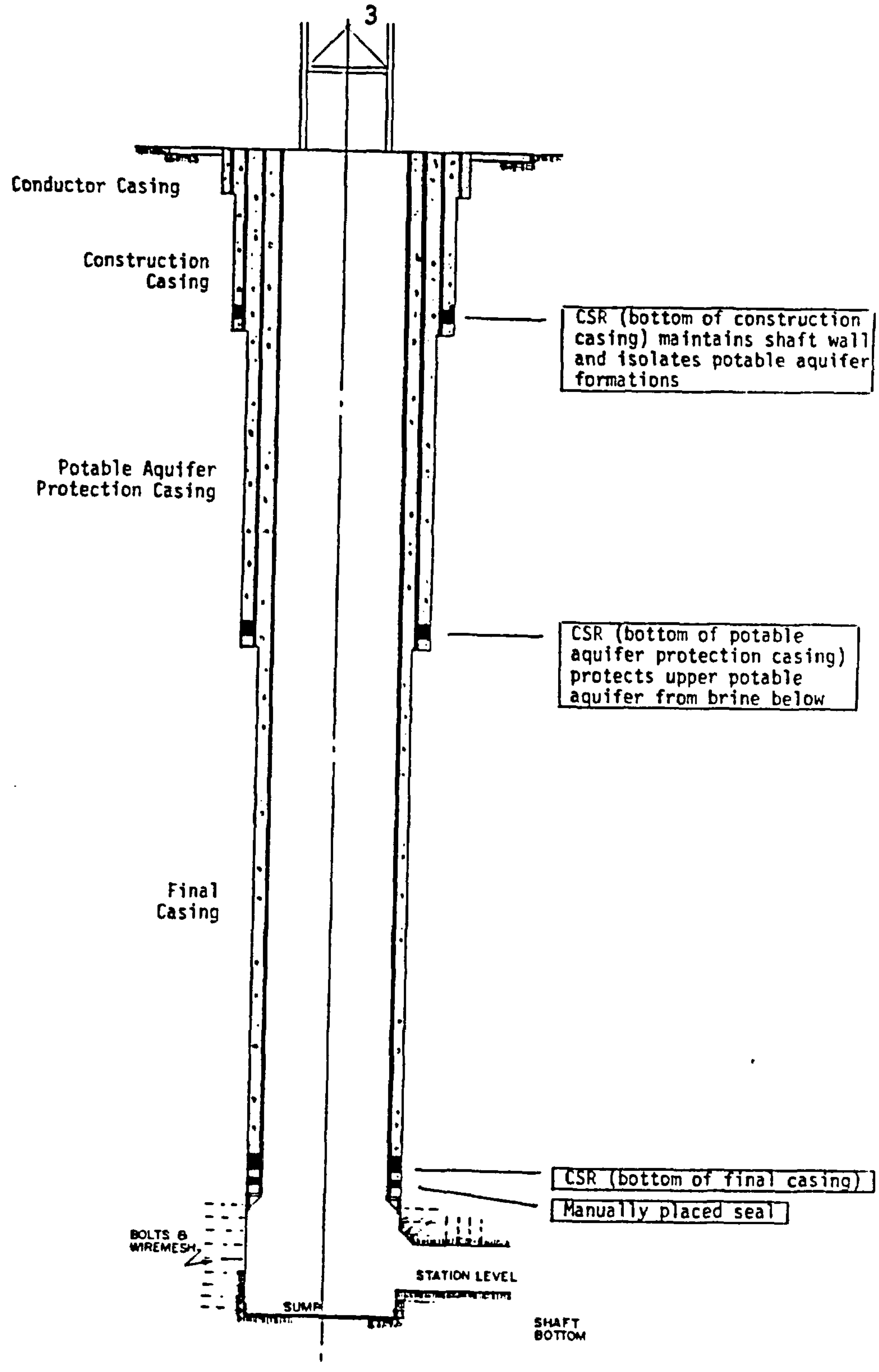


Figure 1. Schematic Diagram of Shaft Operational Seals Showing Chemical Seal Ring (CSR)

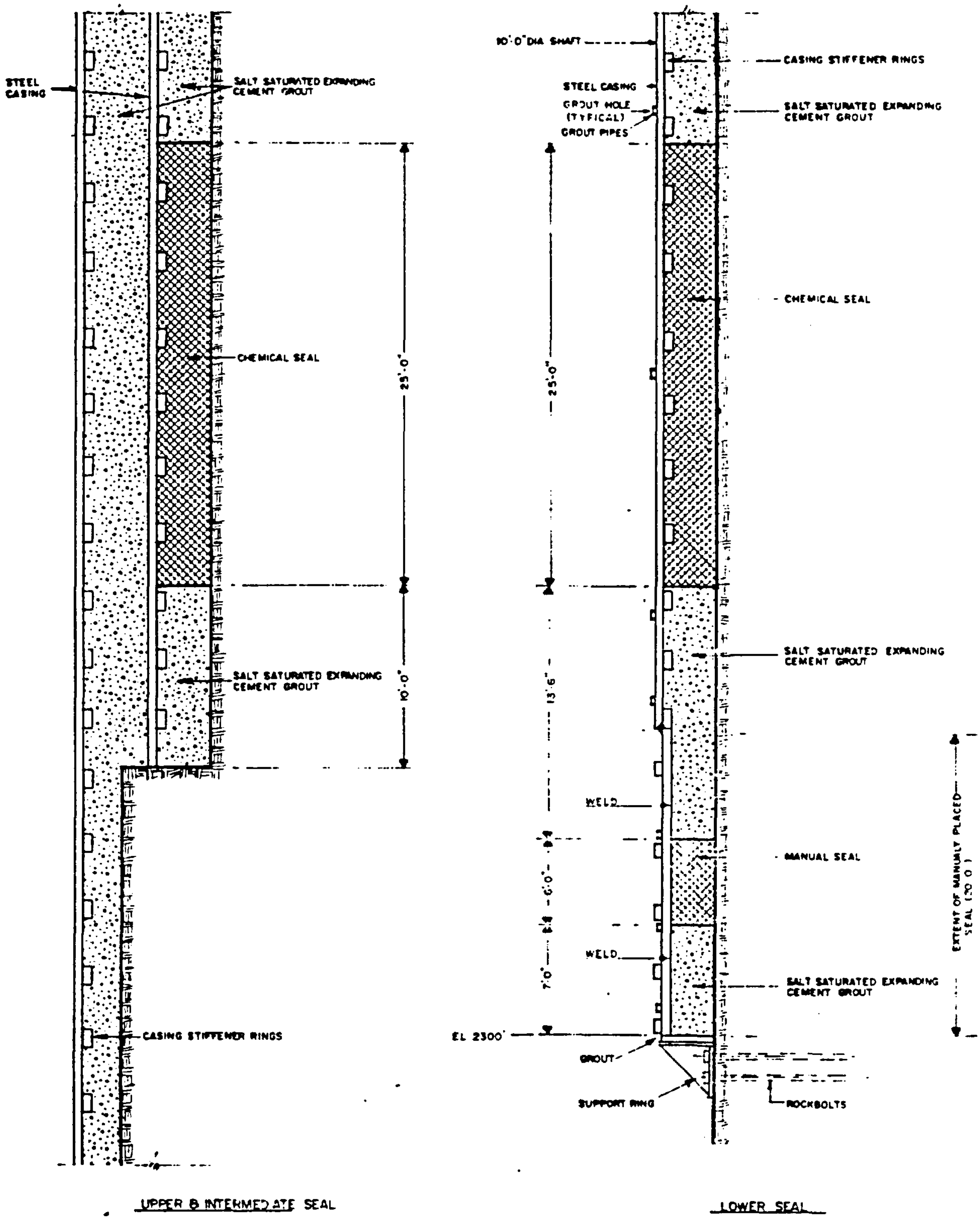


Figure 2. Shaft Operational Seal Components

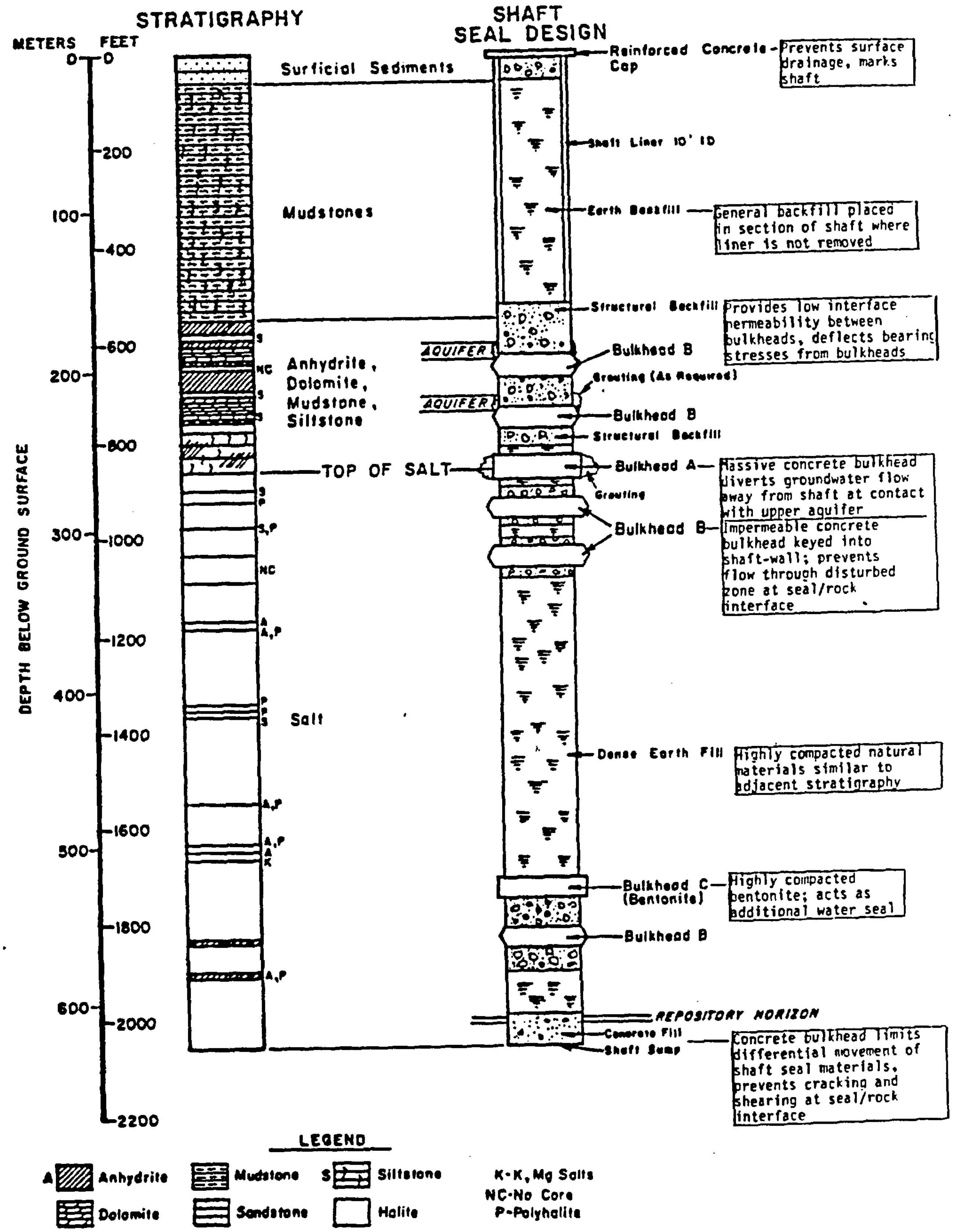
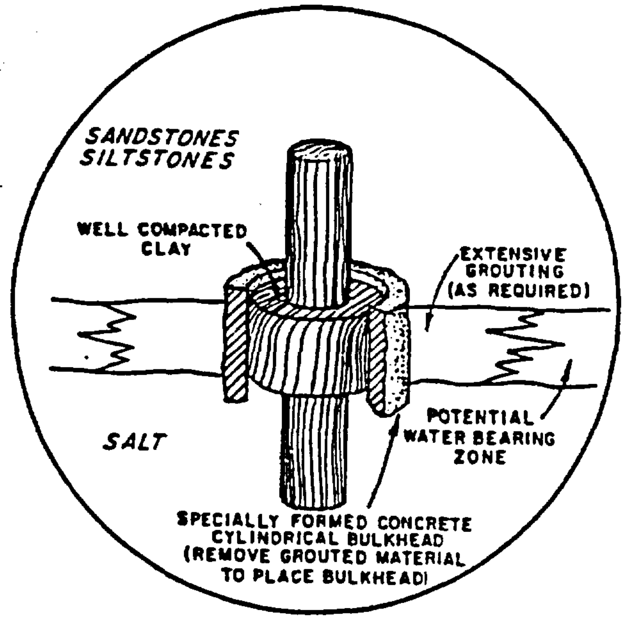
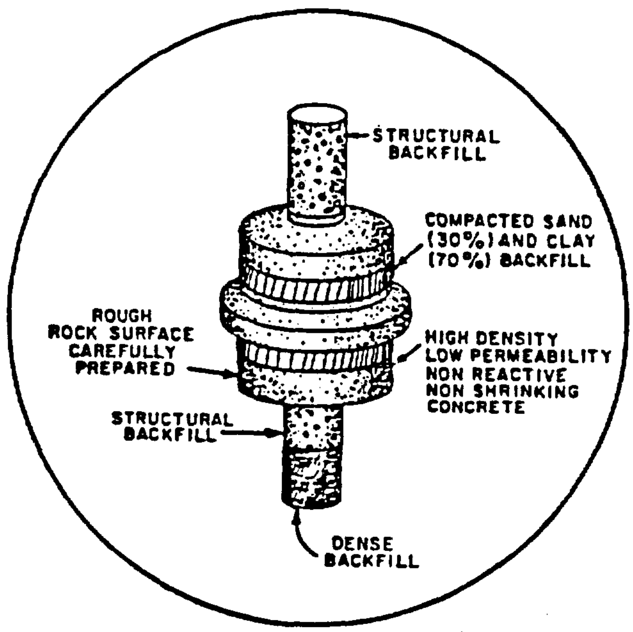


Figure 3. Schematic Diagram of Shaft Decommissioning Seals



Type "A" Bulkhead at top of Salt



Type "B" Shaft Bulkhead

Figure 4. Shaft Decommissioning Seal Components

E. Discuss the selected locations of any planned explorations or testing to be performed along the length of the shaft. Include discussion of data on sealing characteristics to be gathered and the limitations and uncertainties associated with the data.

Current plans call for drilling an engineering design borehole (EDBH) at the exploratory shaft site to obtain design and site characterization data.

The only tests planned along the length of the shaft concern monitoring the shaft and shaft-liner behavior (Reference 12). Measurements will include axial and radial deformation, and shaft tilt. The buildup of water pressure behind the liner will be monitored in important water-bearing units. The locations of tests along the shaft will be dependent upon the stratigraphy and must await site selection. There are no plans for testing the decommissioning seal components in the exploratory shaft.

Since at least portions of the cement casing grouts will be based on formulations being developed for the decommissioning seals, there will be the opportunity to observe their performance over the ES operational life.

II. CONSTRUCTION PLANS AND PROCEDURES

A. Identify the acceptance criteria for construction of exploratory shafts.

The design criteria for the ES construction are identified in Reference 8. A document defining specific tests and acceptance standards to verify conformance to Functional Design Criteria will be developed in late FY 84 or early FY 85.

B. Identify procedures used to minimize damage to the rock mass penetrated and specific plans to mitigate these effects, if applicable to a proposed site.

The procedures used to minimize damage to the shaft-wall rock mass include emplacement of multiple casings (liners) and a carefully formulated and controlled drilling fluid (mud) program.

In the Permian Basin, for example, drilling difficulties are likely to be encountered in the Ogallala, Dockum, and upper Alibates formations where historic borehole wall collapse has occured despite the presence of drilling mud. The worst case collapse would result from "flowing sand", i.e. the inward movement of loose sand under water pressure. To minimize the potential for shaft wall collapse during drilling, multiple casings are provided for in the design to (1) isolate aquifers, and (2) reduce the open hole time. (References 1, 2)

<u>Multiple Casings</u>. The first of these casings will be set at the base of the Ogallala formation, and thereafter protect the hole from caving in that formation. The second protective casing will be set in a competent zone in the Alibates, which immediately underlies the Dockum formation. The rocks below this point are indicated to be more competent than those above and may not present difficult conditions.

Controlled Drilling Fluid Program. The advance formulation and field control of the fluid used to maintain an open borehole is a science developed through years of oil-field experience. The principle parameters which can be varied by the fluid (mud) engineer are the weight, viscosity, and chemistry of the fluid. A fairly simple two-phase fluid program has been formulated by the ES A/E consisting of: (1) bentonite/fresh water used to the top of the Alibates formation, and (2) salt gel/saturated brine used to the bottom. Of critical importance is the field monitoring and control of the fluid characteristics as the hole is advanced. Detailed mud programs will be developed.

Prevention of Hydrofracturing. Hydrofracturing refers to the failure of the shaft-wall rock mass when the minor horizontal principal stress is exceeded by the hydrostatic stress of the drilling fluid column. This should not occur unless the fluid is pressurized or becomes too dense. The fluid weight will be constantly monitored by the mud engineer, and will not be pressurized at any time.

Assurance that hydrofracturing did not occur will be found in the mud records, confirming that the necessary conditions were never present, and through visual inspection of the uncased salt section above the target horizon.

Drilling procedures will be developed to control other drilling parameters such as weight on the bit, bit speed, etc.

C. **If a liner is used, identify liner construction and placement techniques. This information needs to be fully considered in application of any permanent sealing program.**

Multiple liners have been designed for various proposed sites. In the Permian Basin, for example, four sets of liner casing (Figure 1) are required to support the shaft walls and prevent ground water migration (References 1, 2).

The conductor casing (21 feet 10 inches inside diameter) is designed for ground pressure and installed to 100 feet to provide a starter hole for the large hole drill rig.

The construction casing (17 feet 10 inches inside diameter) is installed next by "floating" it into the mud filled hole. A cement plug in the bottom provides the casing with buoyancy. As additional sections are welded on at the surface, the casing is slowly sunk by compensating the buoyancy with water. After the 400 feet of construction casing has been fully assembled (and is resting at the bottom of the hole) it is cemented in. Perforated grout lines are attached to the outside of the casing for tremie pumping cement grout or Chemical Seal into the annular space between the casing and the shaft wall. The cementing stages for the construction casing consist of placing:

- An expanding cement from 400 feet to 390 feet.

- The Chemical Seal Ring from 390 feet to 365 feet to seal off the Ogallala fresh-water aquifers from the strata below.

- More expanding cement up to 265 feet.
- Prehydrated filler cement from 265 feet to the surface.

The bottom cement plug of the construction casing is then drilled through. The potable aquifer protection casing (13 feet 10 inches inside diameter) is welded together, the welds are 100% tested, and then floated in through the construction casing to a depth 1100 feet. The cementing stages for the aquifer protection casing consist of placing:

- An expanding cement from 1100 feet to 1090 feet.
- The Chemical Seal Ring from 1090 feet to 1065 feet to seal off the fresh water aquifers of the Dockum.
- More expanding cement from 1065 feet to 925 feet.
- Prehydrated filler cement from 925 feet to the surface.

The bottom cement plug of the potable aquifer casing is then drilled through, and drilling is continued to the final depth in the target salt horizon. After drilling to final depth, the shaft is filled with sand to a level which will serve as a reliable base for the first stage of final cementing. The final casing (10 feet inside diameter) is welded together and floated in to depth of 2280 feet. The final casing has a hemispherical steel bottom (hemi-head) instead of a cement plug. The cementing stages for the final casing consist of placing:

- A salt saturated cement at the bottom of the casing.
- A Chemical Seal Ring is set above the bottom cement to prevent migration of water down into the salt.
- More salt saturated expanding cement is placed above the CSR
- Prehydrated cement filler is placed in the remaining distance to the surface.

The mud in the final casing is pumped out. The hemi-head and sand are removed, and an additional seal is manually placed under the cement. The manual seal is placed beneath the final liner. This seal provides additional assurance of a sufficient final casing seal. Valves, in the casing liner, will provide for later injection of cement grout or chemical seal if needed for remedial repair.

III. SEALING AND GROUTING PLANS AND PROCEDURES

A. Describe how the seals are expected to perform in sealing exploratory shafts. Describe tests done, both laboratory and field, to determine their long-term durability and their compatibility, both chemical and physical, to the host rock environment.

The shaft decommissioning seals are expected to perform by restricting fluid movement along the shaft. The principal parameter affecting such movement is the hydraulic conductivity of the fluid filled shaft including the surrounding rock.

Discussion of long term seal performance are given in the following documents:

- Sealing Considerations for Repository Shafts in Bedded and Dome Salt, ONWI-255 (Reference 7)
- Performance Assessment of a Shaft Seals System in a HLW Repository in the Gibson Dome Area, ONWI-494 (Reference 13)
- Preliminary Study of Performance Characteristics of a Generic Conceptual Seal System at the Richton Salt Dome (Reference 14)

Much of the sealing materials research conducted to date by Penn State Materials Research Lab, Waterways Experiment Station, Sandia, and ORNL has been generic or directed toward lithologies other than salt (basalt, tuff). Despite this, much of the information obtained to date from the materials research program can also be applied to salt (Reference 11).

The thrust of most of the research to date has been directed at the use of cement-based materials for small diameter borehole sealing (Reference 11). Investigations have focused on modified cement pastes and fine-grained grouts with interest centered on:

- Properties of the fresh materials (rheology, setting behavior, bleeding, and segregation tendencies)
- Strength and elastic properties (compressive and tensile strength of the cements, cement/host rock bond strength)
- Volume stability (chemical shrinkage, shrinkage due to loss of evaporable and non-evaporable water, thermal expansion, creep, phase changes, wetting/drying cycles, strain to failure)
- Durability/longevity (metastable/stable cement phases, host rock/cement compatibility, chemical resistance of cements, corrosion of reinforcements).

Only limited work has been conducted to date on mortars and concretes which will be required for sealing shafts and tunnels.

Field tests include the Sandia Bell Canyon Test (WIPP Site) which examined the performance of a cement grout plug emplaced in anhydrite (Reference 15). Terra Tek has conducted laboratory simulated borehole experiments to evaluate permeability of various materials (basalt, anhydrite, salt) plugged with cement grouts (Reference 16).

The short term seal test program will be focused on the Chemical Seal Ring materials, as discussed earlier, and will consider:

- Hydraulic Bond Strength, which has an impact on the seal zone design height and minimum/maximum thickness;

- Chemical Stability (dissolution or interaction with drilling fluid, cement chemistry, and groundwater geochemistry), which has an impact on the considerations given to the formation location of the seal and shaft liner cementing program design;

- Seal Material Rheology (thickening and setting times under the expected temperature conditions), which has an impact on the specifications for sealing material installation procedures;

- Seal Design Configuration (hydraulic pressure resistance per unit length of seal shaft liner), which has an impact on the determination of the total length of shaft seal zone required;

- Component Longevity - CSR has been in use for approximately 20 years (References 3, 4). CSR has undergone accelerated tests in concentrated environments of acid, caustic, brines, ozone, ammonia, hydrocarbons, and fresh water for periods ranging from 90 days to 4 years. In all these tests, the CSR has maintained its integrity and sealing properties without apparent deterioration. Extrapolated values from these tests show that the material should last indefinitely. The chemical reaction by which the CSR is formed indicates permanency. The cross-linkage of the molecules is permanent and the material should be inert to further reaction.

B. Describe the placement methods, including the limitations and uncertainties of the methods.

Operational seals will be placed behind the casing by using grout lines (tremmie method), as discussed previously. The limitation on this method of placement is the minimum clearance between the liner and the shaft wall. The clearance must be sufficient to permit the grout lines to move freely upward during placement, and to prevent void spaces from occurring as the result of "bridging" of the grout. Uncertainties in this placement method concern detection of void spaces that may form. However, cement bond logs should detect such void spaces. In the event of very large void occurrences, remedial actions will be taken as discussed further below.

Placement of the shaft decommissioning seals will require removal of sections of the shaft liner, depending on the nature of the adjacent stratigraphy. In order to reduce the uncertainty associated with increased hydraulic conductivity through damaged shaft-wall rock, the shaft will be over-excavated in critical sections. Manually constructed concrete bulkheads keyed into the shaft-wall, will act as cutoff collars to downward flowing water (References 7, 10).

C. Describe the remedial methods to be used if sealing methods are found to be inadequate.

A sudden major inundation of the shaft by flow through the annulus is not a credible event with a multiple operational seal design (Reference 6). However, if seepage should occur at any point in the shaft, remedial action may be considered appropriate. The remedial methods for reducing seepage include:

- Obtain data from planned sidewall piezometers to determine the approximate source of inflow
- Relieve pressure by grouting through previously installed grout ports in the final casing, or by drilling through the shaft liner above the source of inflow (to avoid the higher hydraulic head of the source)
- Inject a chemical grout, capable of set-up in flowing water, through holes in the shaft liner to seal off the water producing zone
- Verify the effectiveness of the remedial action by monitoring the side-wall piezometers, and by observing that inflow has ceased
- Maintenance of manually placed seal, by injection through existing grout ports
- If necessary, remove and reconstruct the manually placed seal beneath the final casing seal.

IV. CONSTRUCTION TEST PLANS AND PROCEDURES

A. Describe test and inspection procedures to be used during excavation to determine acceptability of the shaft as constructed.

Specific test and inspection procedures to be used during excavation will be developed in detail when Final Design requirements are identified. These procedures will be tailored to be compatible with the excavation method of "blind-hole" drilling.

In general terms, these tests and inspection procedures will be developed and implemented to ensure:

- Shaft diameter is maintained within tolerance
- Shaft verticality is maintained
- Stratigraphic information (drill cuttings) is recorded for evaluation and verification of design
- Loss of circulation is recorded, and loss zones are identified

Direct and indirect inspection techniques are anticipated for use. For example, deviation surveys will be conducted at specified intervals utilizing gyroscopic cluster survey techniques to verify allowable vertical deviation, caliper logs will be run for hole size validation, and drilling rate and hook weight data can be compared to modeling information to confirm anticipated performance and formation composition predictions; this will supplement visual inspection of cuttings obtained during drilling operations.

B. Describe test and inspection procedures to be used during shaft liner construction. Include information such as grout injection rates, grout bond logs, thermal measurement of grout during curing, and liner instrumentation to be used.

These inspection procedures depend on the shaft excavation method of "blind-hole" drilling. The shaft liner will consist of welded steel casing, cement and chemical seals (References 1, 2).

The casing will be welded by qualified welders using qualified procedures in accordance with specified requirements, both at vendor facilities and at the site. Drilling operations will be monitored visually by qualified inspectors. Also, all structural welds will be subjected to applicable nondestructive examination methods, i.e., ultrasonic, radiograph, dye penetrant, etc. Directional surveys will be conducted to determine annular clearance between the casing and excavated hole to assure seal thickness tolerances are adhered to. The results of the examinations, surveys, and tests will be appropriately documented and analyzed; any deficiencies will be controlled and corrected in accordance with approved techniques and procedures.

The cement grout properties will be monitored for compliance to mix design specifications. Since the shaft liner casing has been designed to bear all the structural loads, the mechanical properties (strength) of the cement grout are not significant. Instrumentation and procedures for bond logging will be adapted for shaft diameters greater than 10 feet.

Additionally, cement will be placed by the "tremmie" method of displacing drilling fluids with cement under pressure. Grout injection rate of flow will be monitored and compared with drilling fluid displacement and predicted volumetric requirements to verify competency of the cementing. Liner instrumentation will be installed before and after liner installation.

Casing design will provide for the capability to install instrumentation for monitoring identified parameters.

Chemical seals will be placed remotely and manually (at testing horizon depth) to preclude aquifer movement into the shaft or to the potential repository horizon. The manual emplacement operation will be monitored visually during actual construction. Instrumentation will be imbedded for monitoring seal conditions and to anticipate any necessary remedial measures to prevent water intrusion.

C. **Describe test and inspection procedures to be used after sealing of the shaft to assess the results of the sealing effort in controlling adverse effects. Include information such as grout strength tests, visual identification of seals conditions, records of water inflow, assessment of seal bond to host rock, and logging of drill holes.**

Test requirements and the acceptance criteria to verify the integrity of the operational seals will be developed as part of the final design effort.

The procedures will include provisions for testing the grout quality during its placement to confirm that it meets the mix design specifications, i.e., rheological properties. Specimens will also be made for strength tests.

Visual assessment of the seals condition will not be possible because of the placement method. However, the later installation of piezometers will permit the build-up of water pressure to be monitored, and as such serve as an indication of the grout performance.

The seal bond to rock will be assessed by conducting cement bond logs as discussed above. However, cement bond logs only serve as an indication of cement density behind the casing. A high density usually correlates with a good cement/rock bond. The absolute assessment of bonding will be made by monitoring water pressure build-up, and water inflow, if any.

D. **Describe plans to document the above construction activities.**

A Quality Assurance Program Plan and Manuals will identify management system requirements to satisfy anticipated licensing documentation needs, i.e., ANSI/ASME NQA-1. Procedures will be progressively developed as definitive information becomes available by Design documents and by site selection. Surface construction, drilling operations, subsurface construction, test support, and operations/maintenance procedures will be developed to implement QA Program provisions. A documentation control system will be coupled with Records Management procedures to ensure activities are monitored, necessary information recorded and verified, and submitted to responsible organizations for testing and evaluation of results.

Records of all construction activities such as as-built drawings and specifications, logs, surveys, inspection reports, non-conformance reports, etc., will be maintained.

In general the construction manager will provide the testing of material and workmanship in accordance with design specifications. Independent testing will be conducted by the exploratory shaft architect/engineer as deemed necessary for design verification.

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

A. Describe test plans and procedures used to obtain adequate data on site characteristics that can be measured either directly or indirectly during construction of the exploratory shaft. For example:

- **Geologic mapping and rock mass characterization of the shaft walls**
- **Measurements of rates and quantities of groundwater inflow and collection of groundwater samples for testing**
- **Measurement of mud loss and control of zones of high mud loss**
- **Measurements of overbreakage during blasting**
- **Rock mechanics testing of samples obtained during drill and blast operations**

There are no plans for acquiring data for site characterization during excavation of the ES (as discussed previously). Geologic mapping of the shaft wall will not be possible and as discussed earlier, is not necessary, since this information will be obtained from other sources. A small section of the shaft will remain unlined, however, between the bottom of the manually place seal and the entry at the target salt horizon.

Data will be available as a consequence of maintaining records during drilling. Such data will include:

- drill penetration rates
- mud loss rates
- drill cutting logs.

VI. QUALITY ASSURANCE (QA)

A. **Identify the line of responsibility for implementing QA procedures down to and including the Construction Manager (10 CFR 50 Appendix B. Criterion I requires that "organizations performing quality assurance functions shall report to a management level such that this required authority and organizational freedom, including sufficient independence from cost and schedule when opposed to safety considerations, are provided").**

The QA program for the Exploratory Shaft Facility (ESF) is planned and implemented through the combined efforts of the major project participants (Reference 17). The ultimate responsibility for the effectiveness and adequacy of the overall QA program is retained by the DOE. The DOE has identified in contract documents and other directives the specific quality assurance program responsibilities delegated to the major project participants. All major project participants are required to develop and implement quality assurance programs which comply with 10 CFR 50 Appendix B, and ANSI/ASME NQA-1 Basic Requirements and Supplements for their delegated scope of work. The DOE reviews, approves and audits the major project participants QA program manuals and plans.

The quality assurance responsibilities delegated to the major project participants by the DOE include:

<u>DOE/NPO</u>

- Identify in contract documents or other DOE directives the specific quality assurance program responsibilities delegated to the major project participants.
- Identify in contract documents that all major project participants shall develop and implement quality assurance programs which comply with 10 CFR 50, Appendix B, and ANSI/ASME NQA-1-1979 Basic Requirements and Supplements for their delegated scope of work.
- Review and approve major project participants' QA program manuals/plans and supporting procedures including changes thereto.
- Monitor major project participants activities through periodic QA audits.

<u>Project Integrator (ONWI)</u>

- Develop and implement a QA program meeting the requirements of 10 CFR 50 Appendix B, and NQA-1
- Administer the A/E contract for the ESF excluding Title III engineering services

- Review the Construction Manager's QA program manual and supporting QA procedures as requested by DOE.

- Assist DOE in conducting QA audits and surveillance of major program participants' activities.

Architect/Engineer (Parsons Brinckerhoff/PB-KBB)

- Develop and implement a QA program meeting the requirements of 10 CFR 50 Appendix B, and NQA-1

- Perform QA audits and surveillance during design activities and Title III design verification services

- Interface with the Project Integrator and Construction Manager regarding QA requirements during construction

- Provide Title III design verification services

- Verify inclusion of appropriate QA requirements in technical specifications

Construction Manager (Parsons-Redpath)

- Develop and implement a QA program meeting the requirements of 10 CFR 50 Appendix B, and NQA-1

- Assure inclusion of appropriate QA requirements in construction and supplier contracts.

- Conduct audits, surveillance and inspection of construction related activities

B. Identify the procedures to be used by the Quality Assurance organization for implementing and monitoring the QA program for exploratory shaft design, construction, and testing.

The DOE through the NPO has the overall responsibility for quality assurance of the Salt Project. This responsibility is described in the ONWI Project Quality Assurance Manual (Reference 18).

The Project Integrator is responsible for design and testing quality assurance. Procedures developed for implementing and monitoring these activities support the ONWI Quality Assurance Manual (Reference 19).

The procedures are contained in:

- BPMD Project Management Procedures Manual (Reference 20)

- Engineering Functional Area Procedures Manual (Reference 21)

The Architect/Engineer will be responsible for Title III Inspection Services and will prepare procedures in support of its QA Program Plan (Reference 22).

The Construction Manager will be responsible for construction quality assurance/control, and will prepare procedures in support of its QA Program Plan (Reference 23).

REFERENCES

1. Parsons Brinckerhoff/PB-KBB, 1983. Exploratory Shaft Facility - Preliminary Design Report, Volume 1, Permian Basin (ES-46A-01), prepared for the Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH.

2. Parsons Brinckerhoff/PB-KBB, 1983. Preliminary Design - Exploratory Shaft Facility, Permian Basin, Deaf Smith and Swisher Counties, Texas, Large Hole Drilling Method, drawings and annotated specifications prepared for the Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH.

3. S. A. Pence, Jr. (Dowell Division of Dow Chemical Company) Drips or Blasts - Chemical Seal Ring Stops Water on Gas

4. Dowell Division of Dow Chemical Company, Mining Services Technical Information Sheet - Dowell Chemical Seal Ring

5. Dowell Division of Dow Chemical Company. Service Recommendation - Cementing and Chemical Seal Ring Grouting Service Recommendation, letter from G. A. Correa to S. Poppen, Parsons Brinckerhoff/PB-KBB, September 7, 1982.

6. Office of Nuclear Waste Isolation. Salt Exploratory Shaft Construction Method Recommendation Paper, letter from S. Goldsmith to J. O. Neff, February 14, 1983.

7. D'Appolonia Consulting Engineers, Inc., 1981. Sealing Considerations for Repository Shafts in Bedded and Dome Salt, ONWI 255, prepared for the Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH.

8. Office of Nuclear Waste Isolation, 1983. Functional Design Criteria for the Exploratory Shaft in Salt, ONWI-455, Battelle Memorial Institute, Columbus, OH.

9. D'Appolonia Consulting Engineers, Inc., 1982. A Preliminary Evaluation of the Rock Mass Disturbance Resulting from Shaft, Tunnel, or Borehole Excavation, ONWI-411, prepared for the Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH.

10. D'Appolonia Consulting Engineers, Inc., 1982. Schematic Designs for Penetration Seals for a Repository in Bedded Salt, ONWI 405, prepared for Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH.

11. Pennsylvania State University Materials Research Laboratory, 1983. Selection and Durability of Seal Materials for a Bedded Salt Repository, ONWI-479, prepared for the Office of Nuclear Waste Isolation, Battelle Memorial Institute, Columbus, OH.

12. Office of Nuclear Waste Isolation, 1983. Conceptual Test Plan for Site Confirmation Testing in an Exploratory Shaft in Salt, ONWI-493, Battelle Memorial Institute, Columbus, OH.

13. Office of Nuclear Waste Isolation, 1983. Performance Assessment of a Shaft Seals System in an HLW Repository in the Gibson Dome Area, ONWI-494, Battelle Memorial Institute, Columbus, OH.

14. Office of Nuclear Waste Isolation, 1983. Preliminary Study of Performance Characteristics of a Generic Conceptual Seal System at the Richton Salt Dome, letter report to J. O. Neff, Battelle Memorial Institute, Columbus, OH.

15. Christensen, C. L. and T. O. Hunter, 1981. The Bell Canyon Test Summary Report, SAND 80-1375, Sandia Laboratories, Albuquerque, New Mexico.

16. Burns, F. L., R. Lingle and A. Andrews, 1982. Cement-plug Leakage and Drilling Damage Evaluated, Oil and Gas Journal, November 22, 1982.

17. U.S. Department of Energy National Waste Terminal Storage Program Office, August 1983. Exploratory Shaft Facility (ESF) Project Management Plan.

18. U.S. Department of Energy, December 1982. Quality Assurance Manual, ONWI Project, National Terminal Waste Storage Project Office (NPO), Columbus, OH.

19. Office of Nuclear Waste Isolation, April 1983. Quality Assurance Manual, Battelle Project Management Division, Columbus, OH.

20. Battelle Project Management Division, BPMD Project Management Procedures Manual, Battelle Project Management Division, Columbus, OH.

21. Office of Nuclear Waste Isolation, Engineering Functional Area Procedures Manual, Revision 0, Battelle Project Management Division, Columbus, OH.

22. Parsons Brinckerhoff/PB-KBB, November 1983. Exploratory Shaft Facility Quality Assurance Program Plan

23. Parsons-Redpath, June 1983. Exploratory Shaft Facility Quality Assurance Plan.