THE SITING AND LICENSING ROLE OF THE EXPLORATORY SHAFT FACILITY

Dean Stucker
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
Washington, D.C. 20585

James E. Montgomery
Weston OCRWM Technical Support Team
Jacobs Engineering Group, Inc.

ABSTRACT

The test facility that will provide the access and support for in-situ testing and monitoring activities at each of the three candidate horizons for the first repository is called the exploratory shaft facility (ESF). Laboratory data and surface findings will be combined with the in-situ test activities to allow final assessment for site determination and verification of design parameters for repository design and license application. The ESF will be used to collect data for repository site selection, for the validation of parameters in the designs of the repository and the waste package, for confirmatory testing in support of the license application, and for intiating performance confirmation.

INTRODUCTION

On May 28, 1986 the site-characterization phase of the first-repository program began with the Presidential approval of three candidate sites. The three sites are Deaf Smith County, Texas (bedded salt); Yucca Mountain, Nevada (tuff); and Hanford, Washington (basalt). The purpose of site characterization is to establish and validate the geologic conditions at each candidate site by means of surface-based investigations (e.g., seismic surveys), investigations conducted by means of deep and shallow boreholes, laboratory tests, and, most important, in-situ testing and monitoring conducted in the host rock at the proposed depth of the repository. The test facility that will provide the access and support for the in-situ testing activities at each candidate site is called the exploratory shaft facility (ESF) and consists of surface support buildings, two shafts, and subsurface excavations.

Before proceeding to sink shafts at any site, the DOE must submit, for review and comment, a site-characterization plan (SCP) to the Nuclear Regulatory Commission (NRC), the Governor and legislature of the State, the affected Indian Tribes, and the public. This plan will describe the investigations and tests identified as necessary by the issue-resolution strategy. The sinking of shafts will start after public hearings have been held in the vicinity of the site and comments have been evaluated and addressed as appropriate.

The in-situ testing will be conducted in two phases. The first phase, construction testing, is defined as the tests and investigations starting with shaft construction and continuing until the underground connection of the shafts is completed. The second phase, in-situ testing, will start at the completion of construction testing and continue until sufficient data have been collected. These tests will concentrate on characterizing the rock mass; they will assess such things as in-situ stress, permeability, thermomechanical parameters, geochemical properties, thermal properties, heat dissipation, and hydrologic properties.

This paper discusses the purposes of the ESF and provides a general description of the facilities including basic requirements and design criteria. It then presents brief illustrated descriptions of the design concepts at each candidate site.

PURPOSE OF THE ESF

The ESF will serve several purposes in site characterization and in the repository. Its principal role will be to provide data for repository design, siting, and licensing. In particular, the design data will be used to establish and validate the parameters used in the design of the repository and the waste package. The siting data will be used in the environmental impact statement (EIS) that will support the selection of the repository site. When this data-collection effort has been completed, additional confirmatory testing will be conducted in the ESF to support the license application that will be submitted to the NRC in order to obtain a construction authorization for the repository. The data collected during site characterization will be used to demonstrate that the site meets the requirements of the DOE siting guidelines (10 CFR Part 960) and the NRC technical

criteria (10 CFR Part 60). The plans and the rationale for the collection of design, siting, and licensing data will be described in the site characterization plans. For the most part, all of these data will be collected from the same tests with different data-cutoff dates.

Another purpose of the data collected in the ESF will be to confirm that design specifications were met during ESF construction. This confirmation may have a bearing on the licensability of the repository.

After a site has been selected and a construction authorization has been granted by the NRC, the ESF will be used to aid repository construction and may be used in repository operations. In order to maintain the overall capability of incorporating the ESF into the repository, certain permanent components and features of the ESF will be designed to have a maintainable life and quality as specified for similar repository items. This has required that a preliminary impact assessment of repository safety and waste isolation be conducted. Assessments to date indicate that there are no components or features in the ESF that will affect repository safety or waste isolation.

Finally, the ESF will be used to initiate confirmation testing in accordance with NRC requirements. The objective of this testing is to confirm that the repository is performing as expected and to eventually obtain from the NRC a license amendment that will permit the repository to be permanently closed and sealed.

TEST FACILITY

The exploratory shaft facility at each candidate site will consist of two exploratory shafts, a drift that connects the shafts, underground rooms for testing with connecting drifts, underground shop and support areas, and associated surface support facilities. The shafts at the tuff and salt sites will be sunk by conventional drill and blast shaft-sinking methods; and the shafts at the basalt site will be sunk using a large-diameter blind-drill method. The shafts have been sized to support the in-situ testing and monitoring needs for the site characterization phase only, and range from 12 to a 6 feet finished diameter, depending on site specific conditions and test requirements. The test areas are located so that the test data generated are representative of the general geologic characteristics of the repository area. This representativeness may be somewhat tempered to ensure that the test facilities do not impact the repository designs later.

The program requirements for the ESF are specified in the Nuclear Waste Policy Act of 1982, 10 CFR Part 960, 10 CFR Part 60, and the Generic Requirements for a Mined Geologic Disposal System (GR-MGDS) Appendix E. The project requirements will be identified in each site specific design requirement document.

The issues hierarchy, issue resolution strategy, GR-MGDS, and advanced design studies may result in future changes to the design concept presented herein.

Basic Requirements

The design of the facilities will be based on requirements defined in the site characterization plans (SCP) at the time design begins. Since some change in the SCPs must be expected, all major systems will be analyzed to determine the need for additional capacity or space to allow for changes. Other requirements that must be satisfied by the facility are listed below.

- Provide access to the candidate repository horizon and the underground portion of the ESF.
- Provide for testing in the shafts as required.
- Provide a suitable location for in-situ testing.
- Provide design and construction methods that will demonstrate licensability and constructability for the candidate repository.
- Provide an ESF that can be incorporated into the repository and can be used to support repository construction.
- Provide utilities for underground ESF operations, in-situ site characterization, and monitoring.
- Support performance confirmation testing.
- Provide equipment and facilities for ensuring a safe, healthful, and productive working environment.
- Provide a quality assurance program.
- Provide for decommissioning and closure of the ESF if the site is not selected as a repository.

Design Criteria and Constraints

The design criteria are based on conventional building and mining codes and standards, and additional criteria have been developed to satisfy NWPA, 10 CFR Part 60, 10 CFR Part 960, and 40 CFR Part 191. Some of these criteria are as follows:

- ESF permanent structures, systems, and components (repository quality) that will be incorporated into the repository shall be designed and constructed with the same criteria, standards, and quality assurance levels as required for the repository to the extent known at the time of ESF design.
- The ESF shall conform with the siting requirements of the Generic Requirements for a Mined Geologic Disposal System.
- The location of the ESF shall be within the candidate repository site and representative of the features and conditions expected at the candidate repository site.
- The thickness, lateral extent, physical and chemical properties, and composition of the host rock for the ESF shall be representative of the candidate repository site.
- All major systems for ventilation, utilities, emergency egress, rock handling, personnel support, and others shall be analyzed to determine the need for the uncertainty allowance. If it can be demonstrated that critical parts of the allowance would require excessive cost, schedule, test disruption or other program impacts to design, procure, and/or construct later (after the basic test plan needs are completed), consideration shall be given to designing, procuring, and/or constructing these critical items as part of the initial facility.

- Shafts and other underground excavations shall be designed and constructed with reasonably available technology similar to or corresponding with the techniques planned for the candidate repository.
- The ESF structures, systems, and components that are incorporated into the repository shall meet the requirements of 10 CFR Part 60. Compliance with the requirements of 10 CFR 60 will be demonstrated at the time of repository license application.
- For the ESF structures, systems, and components that shall be incorporated into the repository as engineered barriers and are important to waste isolation, the criterion applicable to the repository will apply.
- ESF openings, boreholes, and their seals shall be designed and constructed so that they do not become preferential pathways that may compromise the repository's ability to meet the performance objectives of 10 CFR Part 60.
- To the extent practicable, ESF boreholes and shafts shall be located in areas where repository shaft pillars or boundary pillars are planned.
- A quality assurance program that is consistent with the requirements of the Office of Geologic Repositories (OGR) Quality Assurance Plan (OGR/B-3) shall be implemented.
- ESF designers shall coordinate with repository designers on underground location and layout and on permanent ESF structures, systems, and components.
- Permanent shaft structures, systems, and components shall be designed and constructed for a maintainable 100-year design life.
- Underground openings shall be designed and constructed to minimize impacts on in-situ site characterization.
- Testing plans must provide for feedback and modification as a result of initial and ongoing test and monitoring results.
- Testing shall not affect overall site integrity as required by 10 CFR 60.112.

Permanent Items

In order to ensure that site integrity is not compromised during site characterization and to allow the option of incorporating the ESF into the repository, the ESF items that would be difficult and costly to replace were identified and termed "permanent items." These items have the potential to be incorporated into the repository and, therefore, will have requirements consistent with relevant repository requirements, known at this time, except for size and/or function. These permanent items will be designed to have a maintainable 100-year life and quality as specified for the repository. All other items in the ESF are to be considered temporary and designed for a 5-year life, except for environmental items which have a 25-year life. The permanent items and their definitions are as follows:

Underground Openings(s) - space created by mining or drilling, including those zones within the rock altered by that process;

Shaft Liner(s) - all components placed between the inside limits of the shaft and the accessible extent of the underground opening:

Operational Seal(s) - any material placed in an underground opening and/or the peripheral rock for the purpose of controlling the flow of water and/or gas;

Ground Support - any means used to reinforce rock and/or control the movement of rock except for removable or replaceable hardware;

ESF DESIGN CONCEPTS

The concepts being employed by the three projects vary due to the type of tests required, rock conditions, and topography. This section of the report briefly describes the locations selected for each of the ESF's and the testing layouts and drift configurations required. Some of the quantities for drifts, shafts and other items are listed below.

	Salt	Basalt	Tuff
1st Shaft Diameter	12'	6'	12'
2nd Shaft Diameter	12'	6'	6'
Shaft Sinking Method	D&B[1]	Drilled[2]	D&B[3]
Testing Depth	2550'	3160'	1200'
Length of Drifting	5000'	1360'	1300'
Drifting Method	Mechanical	D&B	D&B
Drift Sizes, Nominal	20'x12'	13'x9'	15'x12'

Note 1 - Drill and Blast
2 - Blind-Drill Method
3 - Pilot Bore and Ream 2nd Shaft

These conceptual plans are included in this paper to give the reader a relative perspective of how the projects are planning to develop the test facilities.

Salt Project

A Fig. 1 shows the location of the test facilities with respect to the candidate repository layout at the salt site. In this case the repository shaft-pillar area is situated on one side of the repository and the test facility has been located outside the repository perimeter drifts.

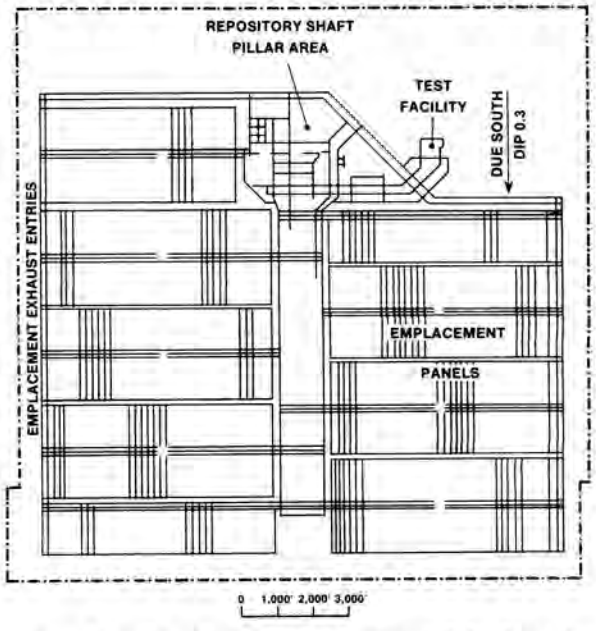

Fig. 1. Test Facility within Proposed Salt Repository.

Figure 2 shows the layout for the subsurface test facility and the various testing rooms. The separation of these rooms is primarily based on the need to isolate the tests which are influenced considerably by the strength of the salt pillars and the induced loading due to depth from surface and extraction ratios. Figure 3 gives the reader a general idea of the type of drift excavation that will be used in the flat lying salt beds.

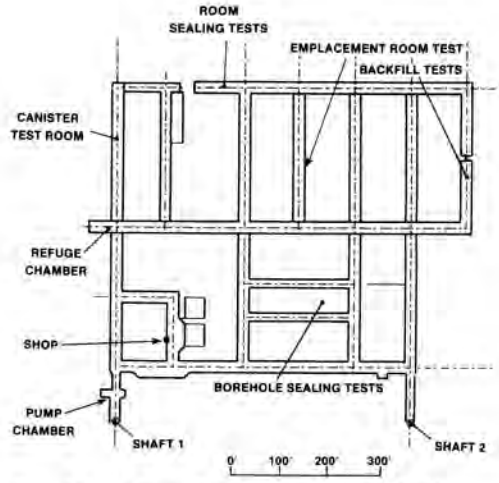

Fig. 2. Subsurface Test Facility at Salt.

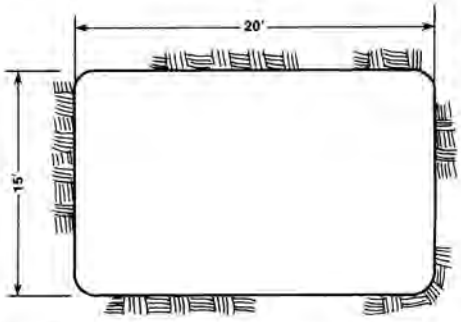

Fig. 3. Typical Subsurface Room at Salt.

Basalt Project

The basalt project also intends to maintain the capability to isolate the test areas from the repository and has located them as shown in Fig. 4. The proximity of the exploratory shafts allows them to utilize the exploratory shafts during repository construction and operations if that is practical. Figure 5 shows the subsurface layout and testing room locations. Figure 6 shows a general view of a typical emplacement room which would be oriented in a manner to best cope with the major stress direction. At each project, the response of the rock to the excavation method and dimensions is an important parameter to the repository designs.

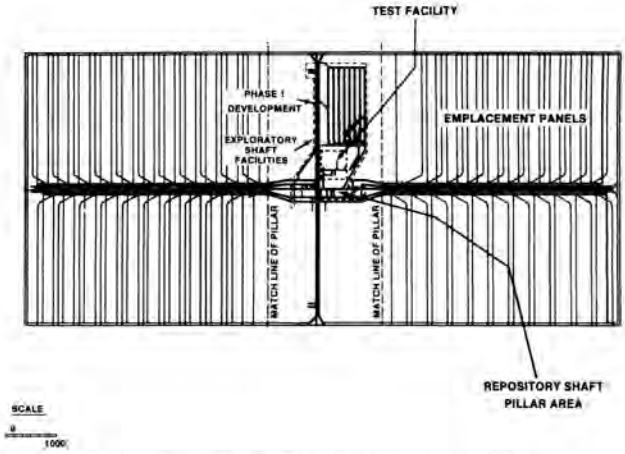

Fig. 4. Test Facility within Proposed Basalt Repository.

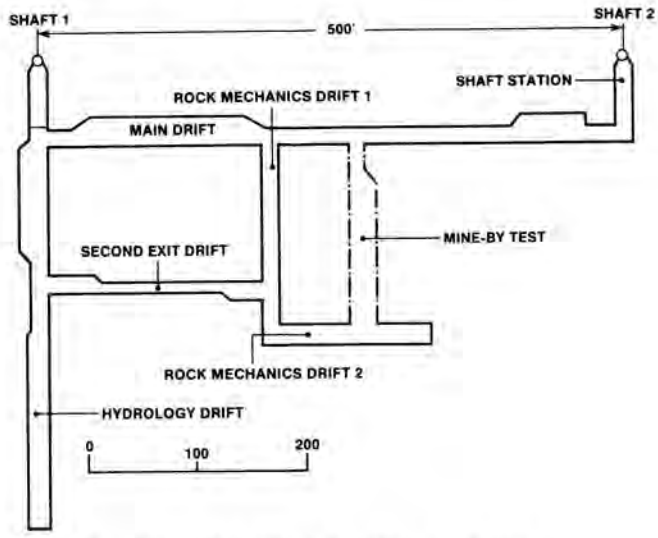

Fig. 5. Subsurface Test Facility at Basalt.

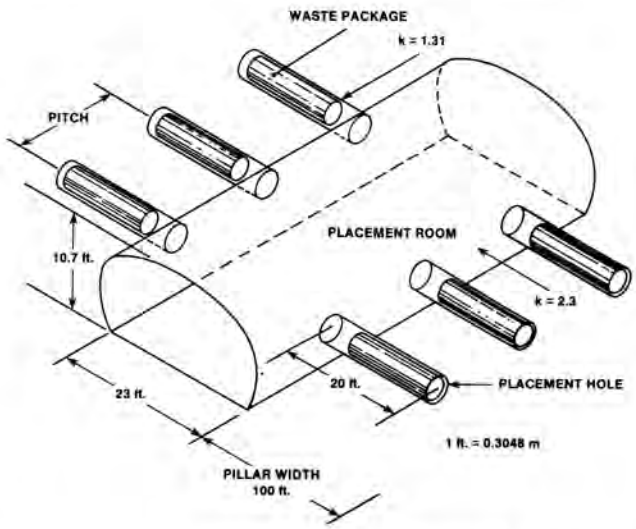

Fig. 6. Typical Emplacement Room Proposed at Basalt.

Tuff Project

The test facility location has been selected to be representative of the overall repository as shown in Fig. 7. The subsurface test facility layout as shown in Fig. 8 includes several long bore holes to probe the fault structures that are believed to intersect the repository horizon.

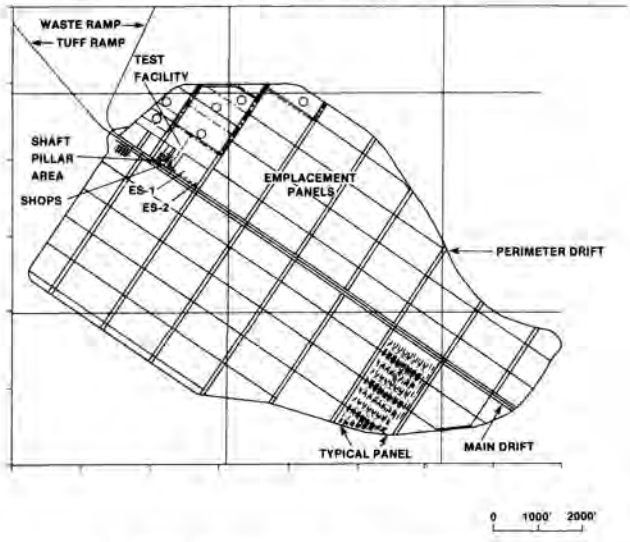

Fig. 7. Test Facility within Proposed Tuff Repository.

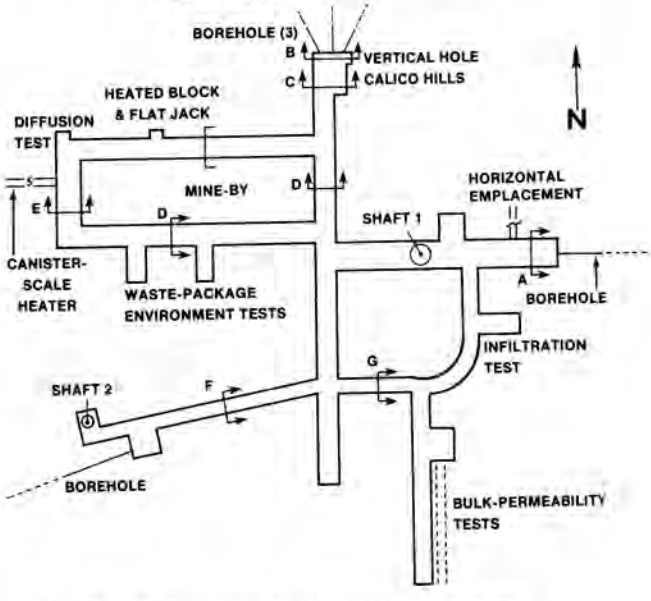

Fig. 8. Subsurface Test Facility at Tuff.

Figure 9 shows a typical emplacement room and pillar configuration for a vertical emplacement mode. The tuff project is planning to characterize the site for both vertical and horizontal emplacement modes.

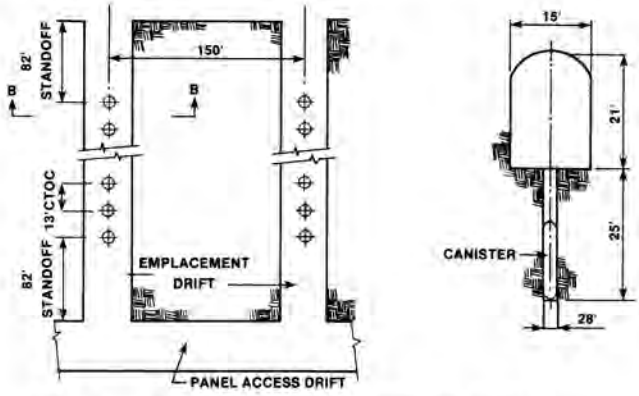

Fig. 9. Typical Emplacement Room at Tuff.

SUMMARY

The ESF will play a major role during site characterization by providing the majority of in-situ data for DOE's site-selection process as well as the data needed to establish and validate the parameters used in the design of the repository, the waste package and the seals. This data-collection phase will be followed by confirmatory testing in support of the license application. After a construction authorization has been received from the NRC, the ESF will be used in repository construction and may be incorporated into repository operations. In addition, the ESF will be used to initiate the performance confirmation program. Careful attention must therefore be given to ESF design, construction, and operation to ensure that all facilities needed for data acquisition are provided, adverse impacts on the site are avoided, and the ability to integrate the ESF into the repository is not precluded.